DOCUMENT RESUME

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ABSTRACT

This environmental education program consists of two levels: primary and intermediate. The learning materials are activity based and incorporate process and subject area skills with knowledge and concern for the environment. The program is also interdisciplinary including activities and skills from several areas. The materials in this set for intermediate and upper grades consist of student activity cards and resource materials. A glossary is provided; it is keyed to the activity cards. (RH)

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the problem:

How are your daily activities affected by your environment? (If you don't know what the word environment means, look it up now!)

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clues for you:

Study the information card, Daily Journal (1-1). This student recorded his activities for one day. Later, he starred(*) all the activities that were affected by the environment.

Make a journal of your activities and observations. Keep a record for at least three typical days. (Hints on what to record: what you do after school and on weekends, what you eat, how you dress.)

Later, go through your journal. Star the items that are due to your environment. Number these items. On a separate sheet, explain how your environment affected each of these activities.

Materials:
information card, Daily Journal (1-1)
data card, Blank Form for Daily Journal, (1-2)
newspapers, magazines, scissors, glue, construction paper.

other ways to look at it:

.. Make a collage. It should show things in your environment. Use pictures from the newspaper or magazines.

.. Write letters to others your own age who live in different environments. Ask about their daily activities. How do they differ from your activities? Do you think this is due to their environment?

.. Read about the daily lives of children in different countries. Compare their activities to yours. Make a chart. Show similarities and differences between you and a student in one other country.

.. Keep a scrapbook about events that directly change the local environment. Examples: filling in a marsh to build a shopping center, a hurricane, automobile exhausts, etc.

.. Look for pictures of people doing the things you do. Add the pictures to your journal.

what did you discover?

Make a poster display. This display should show others how your life is affected by your environment.

SE 022 110

SAILING

CYCLING

FISHING

surfing

camping

hiking

skiing

OUTDOOR SPORTS

MY JOURNAL FOR Saturday, June 1
(day)

6 A. M. Woke up. Got dressed and went[*1] fishing in canal.
7 A. M. Ate breakfast (cereal, toast, fresh[*2] orange juice)
8 A. M. Did the breakfast dishes. Helped Mom with the baby.
9 A. M. Watched cartoons on T. V.
10 A. M. ↓
11 A. M. Helped Dad fertilize the lawn[*3] and spray for chinch[*4] bugs.
12 NOON ↓
1 P. M. Ate lunch (peanut butter & jelly sandwich) - Called Pete.
2 P. M. Pete and I went to beach[*5] and body surfed.[*6]
3 P. M. ↓
4 P. M.
5 P. M. Ate a picnic supper[*7] with Pete's folks.
6 P. M. Watched the fishing boats come into the port.[*8]
7 P. M. Pete, Jack and I rode our bikes[*9] around our development.
8 P. M. Came back home because of mosquitoes.[*10] Watched T. V.
9 P. M. Washed up. Had to clean sand[*11] off bathroom floor.
10 P. M. Worked on my shell collection.[*12] Went to bed.
11 P. M.

MY JOURNAL FOR ______________________

(day)

6 A. M. ______________________

7 A. M. ______________________

8 A. M. ______________________

9 A. M. ______________________

10 A. M. ______________________

11 A. M. ______________________

12 NOON ______________________

1 P. M. ______________________

2 P. M. ______________________

3 P. M. ______________________

4 P. M. ______________________

5 P. M. ______________________

6 P. M. ______________________

7 P. M. ______________________

8 P. M. ______________________

9 P. M. ______________________

10 P. M. ______________________

11 P. M. ______________________

the problem:

Are you less dependent upon your environment than the early settlers of this area?

clues for you:

Some of the earliest settlers of this area were the Ais Indians. Read about them in the information card, Ais Indians (2-1).

How did the Ais Indians depend upon their environment? Make a chart or list. Show how the Ais Indians depended upon their environment for food, clothing, shelter and tools.

Now think about modern man (yourself). Make a second chart or list. Show how you depend upon your environment for food, clothing, shelter and tools. (Remember to trace things you use back to the raw materials.)

Are you less dependent upon your environment than the Ais Indians were? Explain your answer.

Materials:
information card, Ais Indians (2-1)
paper, pencil, chart paper
books on Indians of the U.S.

other ways to look at it:

.. Reread the information card. Do you think the environment of this area has changed since the time of the Ais Indians? What was responsible for these changes? What do you think happened to the Ais Indians? Answer these questions by writing a short story. (You may wish to do some research on your own first.)

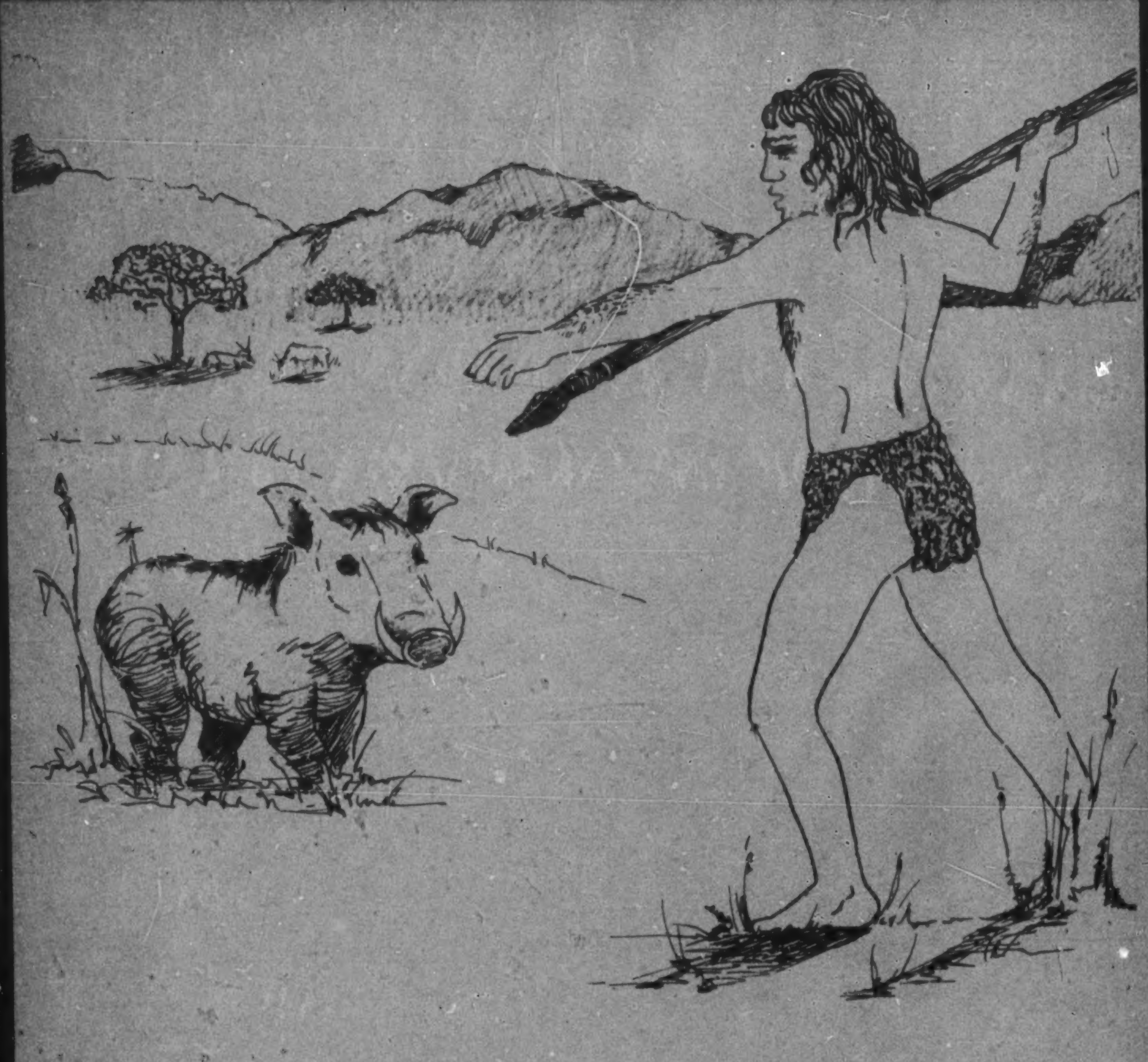
.. Try making tools, clothing or shelter from raw materials. Show your finished product to the class. Explain how you made the product.

.. Read about Indians in other parts of the United States. How did their environment supply the things they needed? Make a chart. Compare Indians from at least two other areas. Show how they obtained food, clothing, shelter and tools.

.. Read about other early settlers in your area. How did they depend upon the environment? How did they destroy parts of their environment? Report to the class.

what did you discover?

Plan a display. Show ways the Ais Indians depended upon the environment for survival. Show how modern man also depends upon the environment for survival.



Information Card

The Ais Indians

The Ais (Ice) Indians lived along the Indian River in Florida. The river was called the "Rio de Ais," by the Indians. They lived from just south of Cape Canaveral to the St. Lucie Inlet. See if you can locate this area on a map. The Ais Indians lived in this area before Christ. They survived until the arrival of the Spanish in the 16th Century. This is a period of about 400 years.

Their early past puts them in the time we call pre-history (before written records were kept). Archeologists have had to get much information about these Indians from artifacts and bones. They found them in middens or mounds. The only written history found about these people comes from early French and Spanish explorers and settlers. An Englishman, Jonathan Dickinson became a captive of the Ais in 1695. He also added to the history of these Indians. The Florida State Park near Fort Pierce is named for him.

From these sources we can get some idea of how these Indians met their basic needs for food, clothing and shelter. For food they gathered and ate blueberries, blackberries, palm berries, wild sweet potatoes and grapes. They also found mushrooms, wild peas, seeds of the palm lillies, and wild crab apples growing here. They hunted the bear, deer and bison.

Nothing went to waste in those days. All parts of the animals were used for something. Bear fat was used as an insect repellent and to color pottery. The deer provided bones for hairpins, needles, and awls. Its ribs were used for bracelets, its horns for war clubs. Its horn tips made arrowpoints, and its ankle bones were necklaces. They made deer skin into dresses. The entrails were used for string. The deer was considered to be the most important animal to the Ais. The bison provided skin for shields, and horns for headdresses. The hair was used for ropes, garters, and belts. The Ais also used other animals in their meat diet. Otters, raccoons, alligators, squirrels, fish and shellfish provided a variety of meat. The beaver, last seen in Florida in 1250, provided strong teeth that were used as tools.

Plants, like animals, played an important part in providing shelter and clothing to the Ais. The rine of the pumpkin was used for masks; green vines made nails. Persimmon roots were used for combs; bamboo-type cane made baskets, mats and fish traps. The inner bark of the mulberry tree was used for thread and cloth ropes. Sumac was used for dying; cypress trunks for dugout canoes, cypress knees for drums. Spanish moss made clothing and pillows. A special kind of root was used to make fish poison.

Because of the mild, sub-tropical climate, the men wore only a breech cloth. It was made from woven straw with a wide colorful belt and a tail of colorful silky grass at the back. They wore their hair in a roll at the top of their heads and often stuck a bone or feather through it. The women wore a raw deerhide dress or a skirt made from plant fibers.

Their homes were a wooden frame covered with palmetto leaves on the top and sides. The posts supporting the center of the roof were longer than the others so the roof looked like an umbrella. Four feet high benches lined the walls inside. These were covered with mats and used for sleeping.

No one knows exactly what happened to the Ais Indians. Their population grew smaller and smaller. They finally disappeared between 1704 and 1736. Some scientists think that attacks from northern tribes killed the Ais. Others feel that some disease brought by the white man wiped them out. Whatever happened, the Ais Indians were able to use the environment to provide all the essentials for themselves rather than depending on supermarkets, building supply stores, or clothing stores as we do today.

Source:

Ais Indians, Brevard Museum Ais Indians Kit.

The Ais Indians

VOCABULARY

1. archeologist - scientist who studies early forms of life
2. artifacts - an object made by man for future use
3. awls - a tool for making small holes
4. bison - a buffalo
5. cypress knees - the roots of a cypress tree which stick up out of the water or the ground
6. entrails - intestines of an animal
7. essentials - things that are needed to live a basic life
8. Jonathan Dickinson - an Englishman who was shipwrecked at Juptier Inlet in 1696 on his way from Jamaica to Philadelphia
9. middens - Indian garbage heaps
10. rine - the outside shell of a mellon
11. sumac - a berry tree with red berries.

the problem:

SURVIVAL-----You and three friends have been picked to go on a Skylab Mission. What will you need to survive in space?

clues for you:

Each person on the trip will need the following amounts:

1½	pounds of food per day
2	pounds of air per day
4	pounds of water for drinking per day
12	pounds of water for cooling and washing

You are allowed to carry 1014 pounds of these items with you. How long can you stay up?

Suppose you wanted a longer mission but could not carry more weight. What could you invent that would let you stay up longer? List these things. Tell why each would increase your air time.

Keep a ship's log about your space survival adventure.

Materials:

information card, What Astronauts Eat (3-1)
pencil, paper, magazines, glue, scissors
Cocoa Cola game, Space Adventure
small scale, construction paper

other ways to look at it:

.. Read What Astronauts Eat. How has NASA solved some of the weight problems?

.. Suppose a disaster prevented your ship from returning on schedule. What would happen? Play the Coca Cola game, Space Adventure to find out.

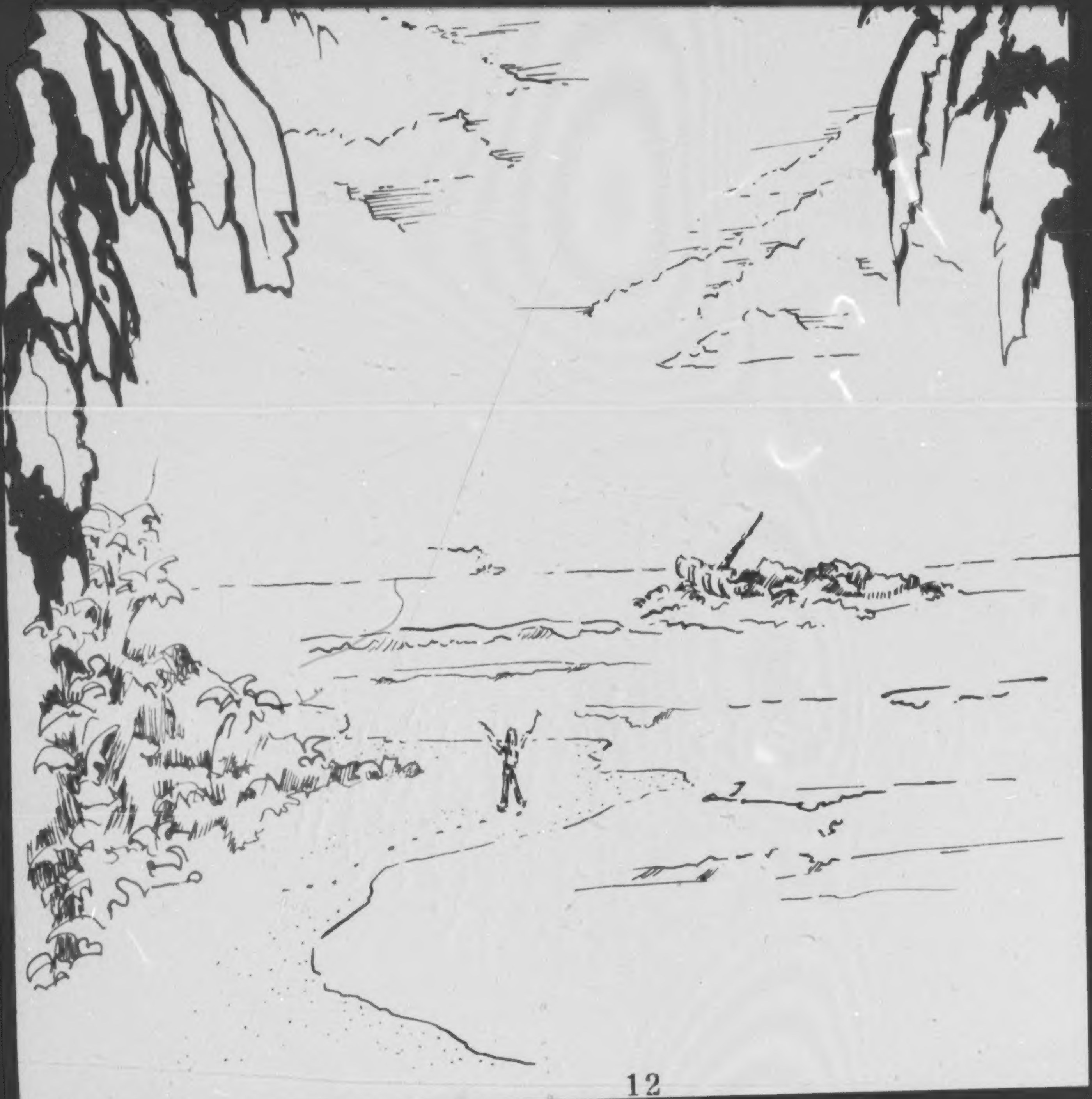
.. Suppose you were marooned on a desert island, the Anarctic, or a ghost town. How would your adventures be different? What makes each adventure different? Pick one of these places. Write a story about your survival adventure. Be sure to include how you found or made shelter, food, clothing and tools.

.. How much food do you eat in one day? Use a small scale. Weight the amount of food you eat in a day. Be sure to include liquids and snacks. Do you eat more than you could take in space?

.. How is our earth like a space ship?

what did you discover?

Make a collage. Show all the materials you need to survive.



What Astronauts Eat

Back when manned space flight was in its early stages, space menus were in their "early stages." Astronauts had to settle for tasteless cubes and bland pastes.

Not so for the Skylab astronauts! When it comes to eating, they've gone first class all the way. The Skylab station is equipped with an advanced food preparation system. It contains five freezers and several storage lockers. It "features" a scientific preparation table. It can heat the main course and keep dessert cool at the same time.

New food preservation techniques have made it possible for the Skylab crews to enjoy a larger menu. Earlier astronauts had to face a dinner that looked (and possibly even tasted) like gray toothpaste. The Skylab astronauts can look forward to filet mignon, lobster newburg, pork and scalloped potatoes, and chicken and rice. More than 70 different food items were included in the Skylab menu. The menu runs through a six-day pattern and then repeats itself every six days.

About 2,400 pounds of food and 6,000 pounds of water were stored aboard the Skylab workshop before launch. The entire nutritional plan for all three Skylab flights, day-by-day and bite-by-bite, has been planned IN ADVANCE. One reason for this is economic. Since it costs $1,000 a pound to put materials in orbit, everything aboard Skylab must be used very carefully. There is an even more important reason for the careful planning. Scientists need to study the biological processes of the Skylab crew members. They can check for possible medical consequences of four-and eight-week stays in space. A third reason is the desire to provide meals which closely resemble normal meals on earth. This gives the astronauts a psychological lift during their long isolation from the usual comforts of life. All nine Skylab crew members taste-tested all the food items before the first launch. Only food which satisfied the astronauts in taste, aroma, shape, color, texture and temperature, was chosen.

How are all these different kinds of food preserved during the long space missions? There are four major methods. The first is dehydration. Dehydrated foods are ready to eat as soon as water is added at the appropriate temperature. Examples of dehydrated foods are scrambled eggs, soup, beverages and desserts. "Intermediate moisture" foods are precooked or fresh with the moisture content reduced. Examples are dry roasted peanuts and cookies. Wetpack or thermostablized foods are stored at a temperature of below -10F. Main dishes such as meatballs and sauce and turkey and gravy are included in this category. The last category is "deep-freeze" foods. They are precooked and then frozen to temperatures below -40F. Included are such foods as prime beef cuts, ice cream, shrimp cocktail, pound cake and pork loin and dressing.

A sample menu for Commander Pete Conrad on the Skylab I mission begins with a breakfast of scrambled eggs, sausage patties, strawberries, bread and jam, orange juice and coffee. For lunch, it is chicken and gravy, asparagus, peaches, biscuit, cocoa and lemonade. For dinner, Conrad enjoys veal and barbecue sauce, mashed potatoes, green beans, with cheese sauce, peach ambrosia with pecans and grapefruit juice. Between meal snacks are coffee and butterscotch pudding.

The menu looks pretty good, but what about the chef? The astronauts take turns performing this important duty. The "chef-of-the-day" checks the menu to see what food and beverages are included in the next meal for each crew member. He then removes the food from the lockers and takes it to the table. The table looks much more like a scientific laboratory bench than a dinner table. Each crewman has a portable food tray with eight food cavities of varying sizes. Some of the cavities operate completely independently. Steaming soup can be just a few inches from frosty ice cream. The "chef" places each crew member's food in the proper compartments, sets the timer and turns on the warmer. He can then return to the many scientific experiments being carried out aboard Skylab. The "stove" works automatically until Mission Control signals the astronauts to turn it off. Foods which require rehydration are prepared at mealtime through the use of cold and hot water "guns" attached to the food table. (Can you imagine an astronaut saying, "Please pass the rehydration gun"?) After each meal the food trays are filled for the next meal, and the heater timers are set accordingly.

It is not only the preparation of food which is difficult in outer space. "Sitting down" to the dinner table is no easy matter, either. To allow for the weightless environment, astronauts stand at the food table in special thigh restraints with their feet in portable foot restraints. For "chairs" they have two horizontal bars, with no backs. One earthly-type nicety is provided, however--dinner music piped in through a stereo system.

All in all, the food storage and preparation system forms an extremely important part of the Skylab mission. Not only does it provide an important means of maintaining and studying the astronauts' helath; it helps make the workshop just a little bit more like home.

--Robertson, Brenda, Today Food Editor,
"What Astronauts Eat," Today Newspaper
Sunday, May 13, 1973, Section D, pp. 1&8.

Questions for Thought

1. Why can't Skylab be equipped with enough water so it can be used freely?
2. Why can't the astronauts eat what they want when they want it?
3. Astronauts can receive proper nutrition through the old "tube foods," so why change?
4. How were the food items on Skylab selected?
5. In what four ways are the foods stored?
6. Who prepares them? How?
7. How do astronauts keep from "floating" away from the dinner table like Uncle Albert in the Mary Poppins story?
8. What songs would you put on the stereo for the astronauts? Do you think they would agree with your selections? Why?
9. If you were a Skylab astronaut, what foods would you "order"? Do you think you would get what you wanted? Why?

What Astronauts Eat

VOCABULARY

1. concentrate: substance which contains a large amount of matter in a small space
2. bland: tasteless
3. preservation: keeping safe
4. techniques: methods
5. nutritional: providing nourishment
6. economic: having to do with money
7. consequences: results
8. resemble: look alike
9. psychological: mental, emotional
10. dehydration: removal of water (usually from food)
11. rehydration: addition of water to dehydrated material (see #11)
12. accordingly: as a result of; in order to agree with something else
13. restraints: something which restrains (holds back)

the problem:

Pretend you are from another planet, seeing your community for the first time. What things do you see that please you? Displease you? Need change?

clues for you:

Take a good look at your community. Study it as if you are seeing it for the first time. What things do you see that displease you? Make a list or take pictures of these things. Do they need to be changed? How could you change them? Make a list of recommendations.

Do you see things you like? Make a list or take pictures. Would you want to see these things changed? How can you keep these things from changing?

After you study your community, make a chart. Divide it into three columns: (1) Things That Displease Me; (2) Things That Please Me; (3) Things That Need Change; Fill in the chart from the lists you make on your walk.

Materials:
pen or pencil
pictures of community
aerial photographs (helpful)
construction paper
camera (helpful)

other ways to look at it:

.. Write a play showing your community in stages of development (past, present, future). Put the play on for the rest of the class.

.. Visit or call your local planning commission. Ask about the changes that are in progress in your community. Ask if there is a plan for the development of the community.

.. Make a display of community changes. Use old maps, aerial photographs, newspaper articles, or pictures.

.. Can you design a perfect environment? Make a drawing or model.

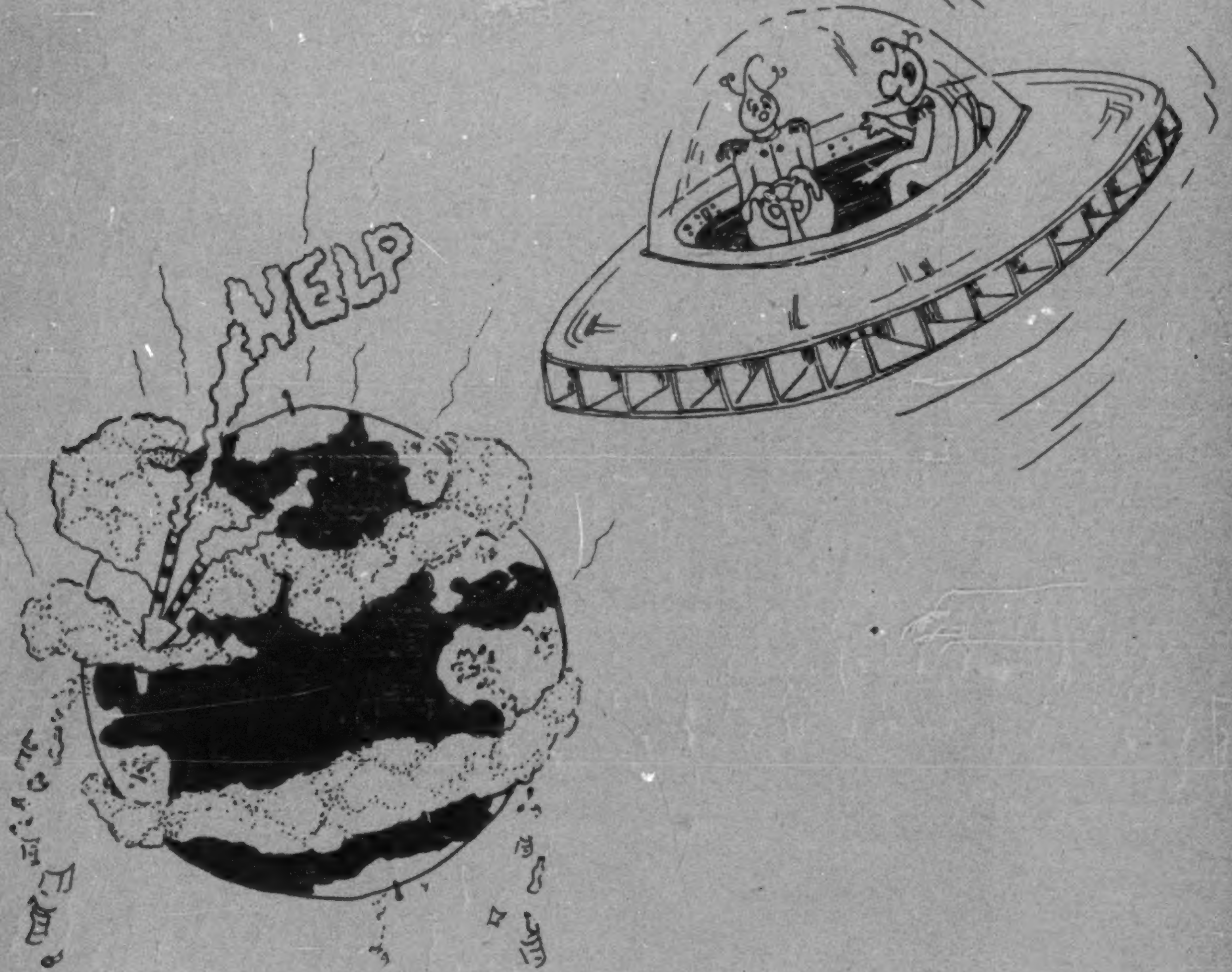
.. Could a visitor tell what sort of life is found in your community by its trash? Study your trash. What things would you know about your family from the trash?

.. Make a scrapbook about your community.

what did you discover?

Make a visual presentation for the class. It should show how you feel about your environment. Ask your classmates if they agree with you. What would they change?

Radio the commander !
We've found the perfect
garbage dump !!



the problem:

How have homes changed? Why have they changed?

clues for you:

Locate some of the older houses in your area. Contrast the style, size, and building materials in these homes with those of present-day houses. Has the environment changed in your area since these houses were built? What has caused the design of houses to change?

Talk to a local builder. Ask him how the construction of houses and apartments has changed in the last twenty years. Ask him what changes he predicts for the future.

After you have completed your research, make a display to show how the design and construction of houses in your area has changed.

Materials:
encyclopedia
poster paper
styrofoam or other scrap materials
"home" magazines
camera (helpful)

other ways to look at it:

.. Not all homes today are built at the homesite. Find out about the construction of mobile homes, modular houses, and prefabricated houses. What discoveries have made the construction of these houses possible? List some advantages of each type of house.

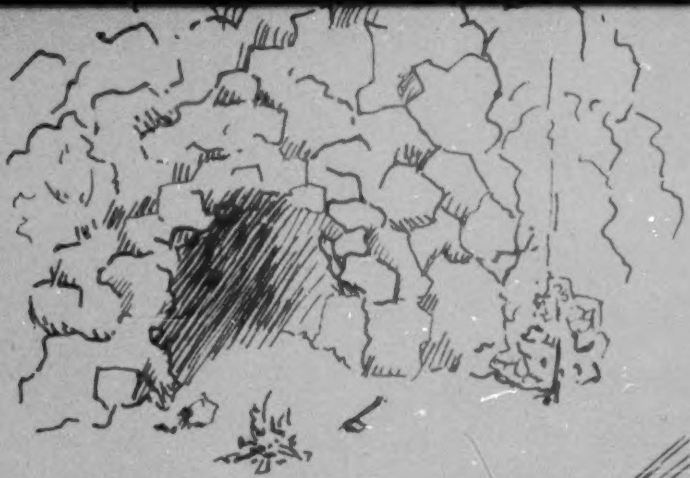
.. Compare the homes of people in different periods of history. Find out: 1) What the environment was like; 2) How the houses were built; 3) What materials were used and why. Present your finding to the class.

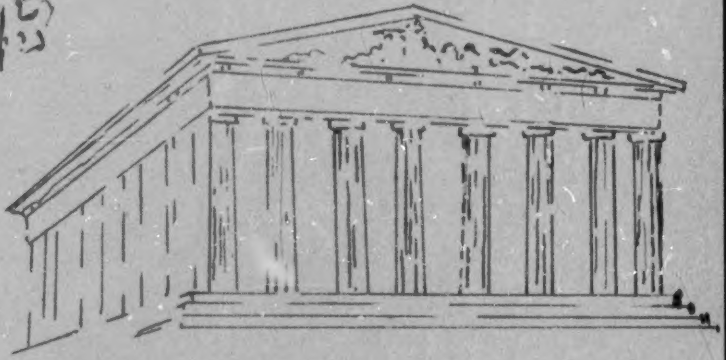
.. Suppose that our environment became unlivable because of some change (pollution, nuclear fallout, drought, etc.) Try to design a house that could serve as a self-contained environment. Build a model.

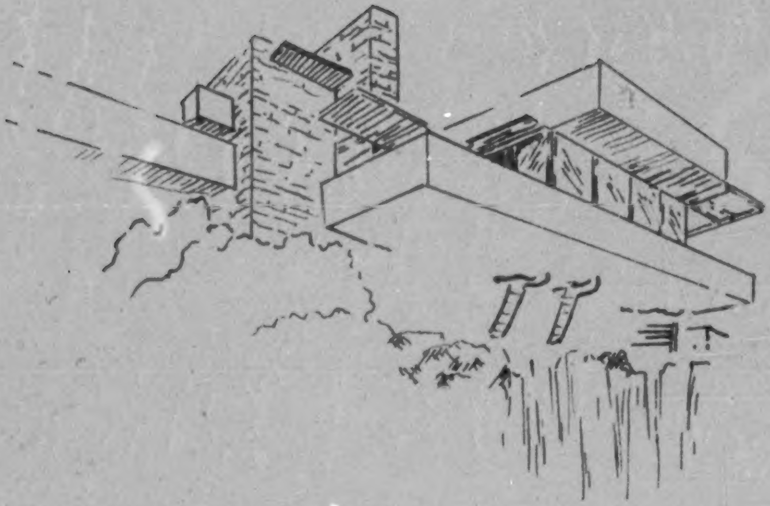
.. Homes of the future will need to use less energy. How can this be done?

what did you discover?

Make a list of the reasons homes have changed. Find some way to show the ways homes have changed.







the problem:

How does the environment influence the type of house you have?

clues for you:

Find pictures of houses in different parts of the United States. How are they different? How are they alike? Make a poster to display your findings. (Be sure to notice style of the house, building materials, and surroundings.)

Make a survey of houses in your area. Compare style, building materials, size, numbers of windows, porches. Do any of the houses have basements or attics? How does the environment influence the design of houses in your area? Record your findings.

What other types of dwellings can you find in your community? How is their design influenced by the environment?

Materials:
magazines, encyclopedia
construction or poster paper
pencil
scissors
camera (helpful)

other ways to look at it:

.. Reseach the types of houses built in different areas of the world. How do these environments influence the design and structure of houses? Make model or illustrations of the houses from these different regions. If you build models, use scrap materials (styrofoam, cardboard, etc.)

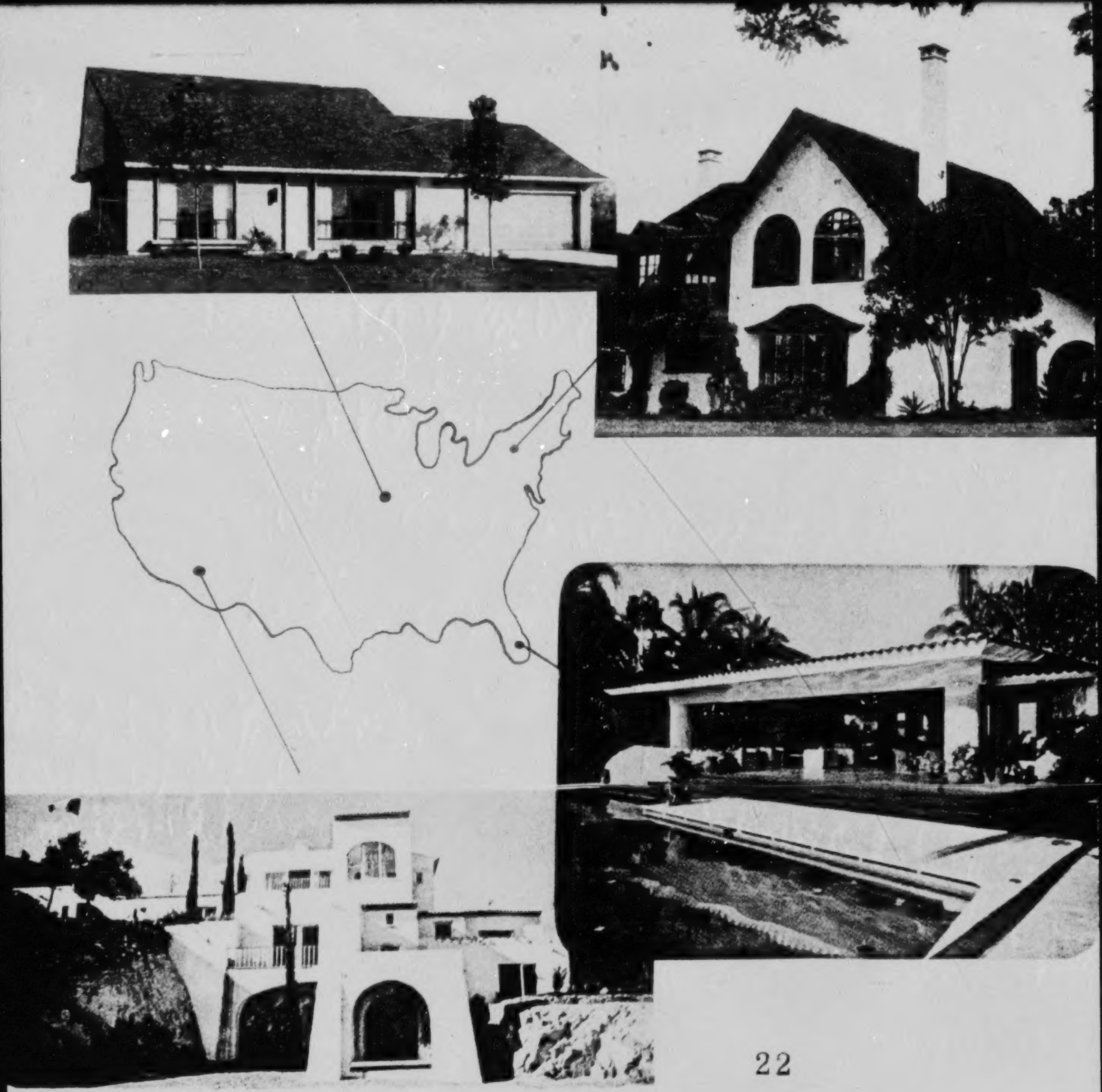
.. Read about Frank Lloyd Wright. Find examples of houses he designed. How did he try to fit the house into the environment? How did he make use of local materials in building houses?

.. What must an architect know about the environment before he designs a house? Find out what architects do.

.. Find out if your local environment presents any special problems for builders (examples: earthquakes, strong winds, freezing). How can these be overcome?

what did you discover?

Make a display. Show how the environment influences the style and construction of houses.



the problem:

How do animals use materials from the environment in building homes?

clues for you:

Start by looking at a bird's nest. Obtain an abandoned nest. A nest that is vacant more than a few days may be considered vacant. Don't worry about taking away a bird's home. A nest in the animal world is a nursery. Once the young birds are able to fly, the nest is abandoned. A new one is built for each hatching.

Examine the nest carefully. Use a hand lens. List all the materials you find in the nest. Note also the shape and appearance of the nest. How is it held together?

How was this animal using the materials from its environment to construct a nest? Keep a record of nest type and building materials.

Materials:
a bird's nest, hand lens
pegboard, string
poster paper

other ways to look at it:

.. Survey your area for the homes of other animals. How do they use the materials provided by the immediate environment? List at least three animals and the types of homes they build.

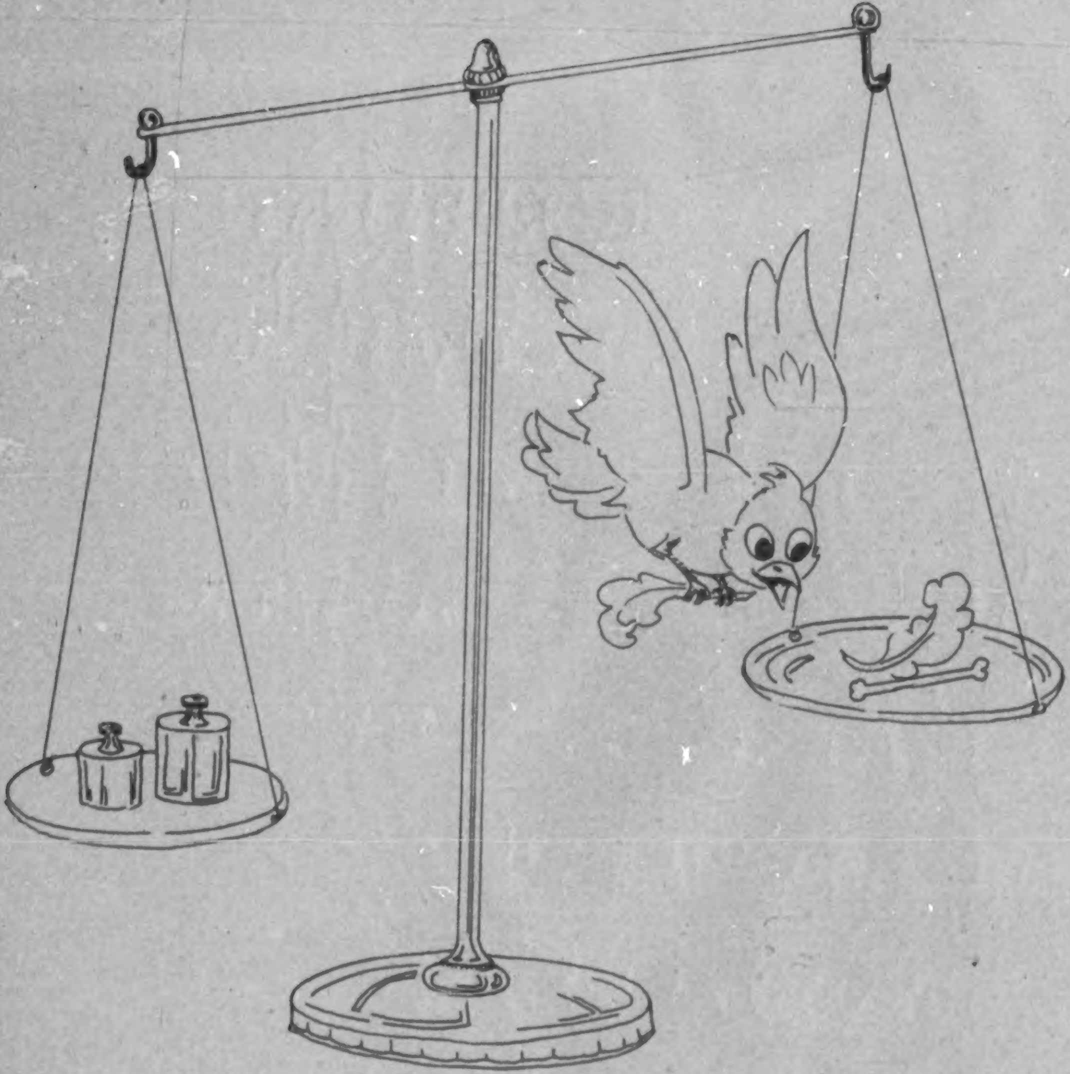
.. Do all nests look the same? Can the type of nest be identified with a certain type of bird? Make a collection of drawings of birds and their nests.

.. In early spring, try this experiment. Make a nest material board (pegboard with pieces of string, yarn, thread, shreds of cloth, etc., pulled through holes). Count each piece. Locate the board near a wooded area. Check the board daily. Replace the materials which have been taken. Keep a record for which nest-building materials were taken first and most frequently.

.. What determines the type of home an animal will build?

what did you discover?

Make a display board showing types and amounts of the different nest-building materials. Show how each material was taken from the environment. Note how the materials were arranged in the nest.



the problem:

How has a changing environment changed the way one earns a living?

clues for you:

Careers are constantly changing. Make a list of jobs the male and female members of your immediate family have had for several generations (two, at least). Add to this list what you would like to do.

Study your list. Do all of the jobs still exist? Did some of the more recent jobs exist twenty-five years ago? How has the role of the female member of the family changed?

How have these changes in jobs affected the environment? How have changes in the environment produced or eliminated jobs? What are some of the other factors responsible for changes in the job picture? Be prepared to answer these questions.

Materials: magazines
pictures
career materials

other ways to look at it:

..Make a "Careers Notebook". Keep a list of the careers you read about in your studies. List also the training needed for each, the income expected, and how the job affects the environment.

..Keep a scrapbook of environmentally related careers in this area. Gather the same information as above. You can start with a fisherman, mechanic, newspaper woman, and a fish and game officer. Keep going from there.

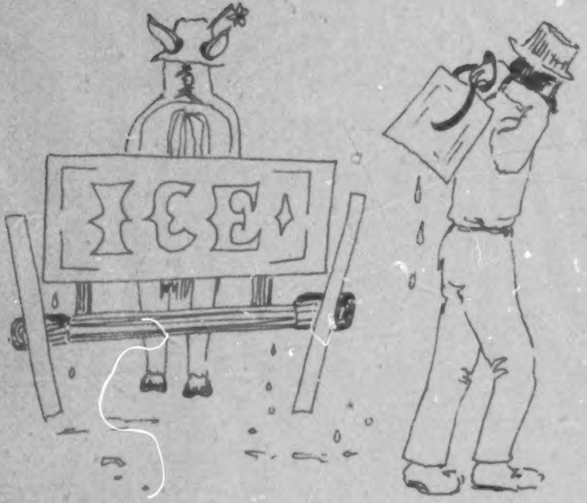
..Keep a list of new jobs that have been created in your area in the last five years.

..Pick one resource in your area(i.e., water). List all of the jobs that depend upon that resource. What would happen to these jobs if the resource were destroyed?

..Find stories about jobs that no longer exist. (Example-Indian scouts.)

what did you discover?

Make a chart or display to contrast jobs that no longer exist and show new jobs. List factors responsible for these changes.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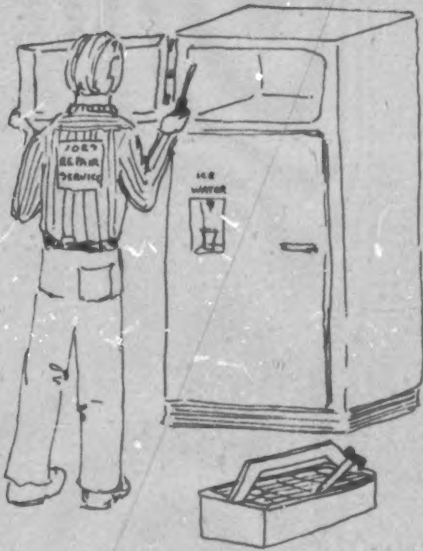
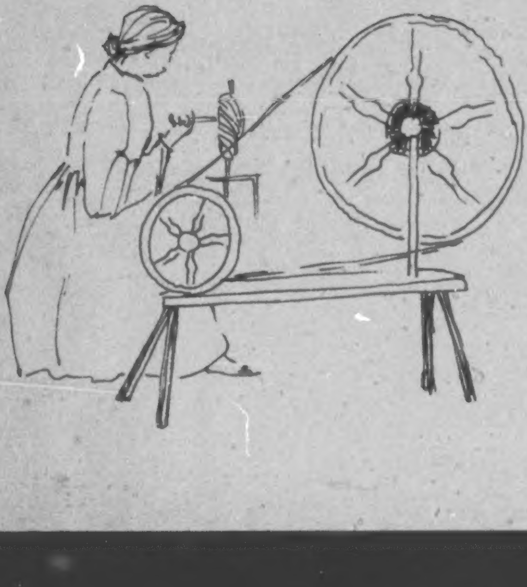
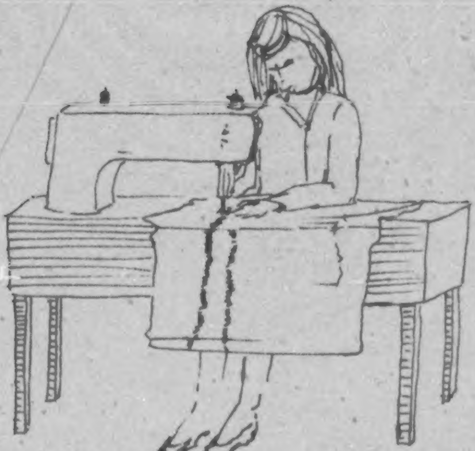

JOE'S
REPAIR
SERVICE
ICE
WATER





the problem:

How does agribusiness affect your area? (Look up the word agribusiness.)

clues for you:

Pick one agribusiness in your area. How does it affect the environment? How does it affect the economy?

Make a list of questions you would like to ask a representative of that business. Then visit the business or invite a resource person to visit the class. Ask your questions. Find out how this business affects you.

Read about this business. List:

a. manufacturing jobs that exist because of this business;
b. service jobs that exist because of this business;
c. environmental problems that exist because of this business.

Materials:

encyclopedia, reference books
pencil, paper
large sheets of paper (for map)
crayons, markers
poster board

other ways to look at it:

.. Find out what the leading agribusiness is in your area. Show how it affects you.

.. Research one region of the U.S. other than your own. List the five most important agribusinesses of that region. Show why the environment of that area is important to the agribusiness. Show how each business affects the environment.

.. Make a survey: Find out if people would be willing to buy less attractive fruit and vegetables if they knew growers would not use pesticides and inorganic fertilizers. Report your findings to the class.

.. Florida is the leading orange growing state. Find out why. Where else would you expect to find oranges growing?

.. Make a class map of the U.S. Show the leading agribusiness of each area on the map.

what did you discover?

Make a poster. Show at least three ways one local agribusiness affects you.

SPRAYING

SHIPPING

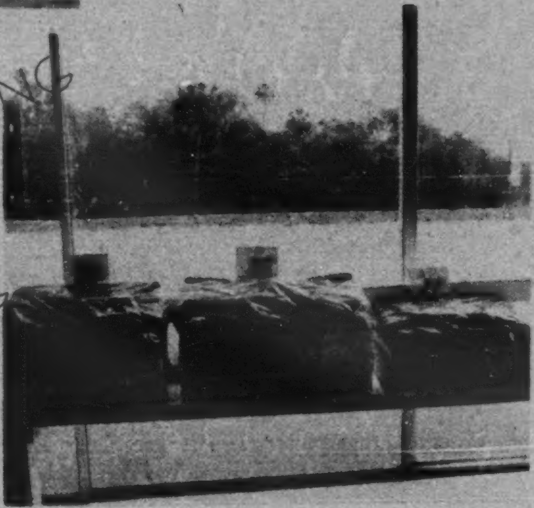
PIC

BUYING

MARKETING

PLANTING

FERTILIZING



the problem:

What does a plant need to grow well?

clues for you:

Look around the school grounds for examples of healthy and unhealthy plants. Try to identify all the factors that might make a difference in the growth of the plants.

Make and complete a chart similar to this:

	Healthy Plant	Unhealthy Plant
Appearance		
Location of plant		
Type of soil		
Amount of moisture		
Amount of sunlight		
Adaptations to location		

Materials:

data card, Plant Survey (10-3)
information card, Hydroponic Gardening (10-1)
chart paper

other ways to look at it:

.. Using the results of your chart, design an experiment to see if a plant can survive without one of these factors, such as sunlight, water, or soil. Record changes in the plant. Share your conclusion with the class.

.. Does a plant need soil? Try the experiment, hydroponic gardening. Follow the directions on the information card.

.. Are there invisible materials that the plant needs? Read about plant nutrients. How does a plant get nutrients?

.. Study the plants that grow naturally in this area. How are they specially adapted to the conditions of this area? Would they survive in a different environment? Where would you find plants similar to these?

what did you discover?

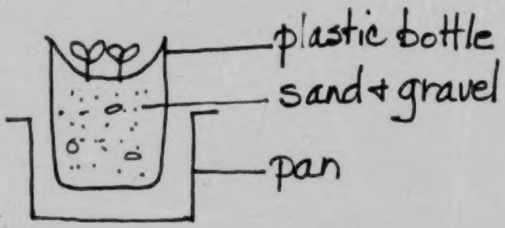
Post your chart and experiment results. Write a paragraph to explain what you think a plant needs to survive.

Two Ways to Make a Hydroponic Garden

Materials Needed:	Optional Materials:
seeds	Epsom salts from a drugstore
gallon jug (plastic)	saltpeter from a drugstore
fine gravel, sand or vermiculite	clear household ammonia
liquid plant fertilizer	baking powder with calcium phosphate
metal pans (aluminum)	

Growing plants with water and minerals is called hydroponics (hydro means water, and ponics means cultivation). Plants will grow in a sand-gravel mixture or in vermiculite if they are watered daily with a mineral solution.

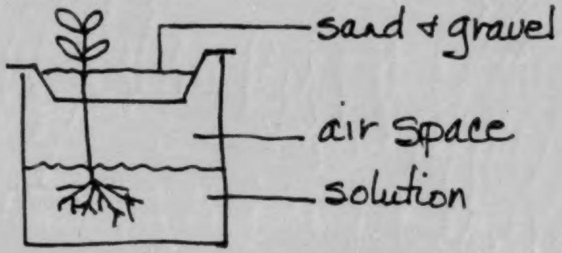
To prepare the fertilizer solution, wash out a gallon jug very carefully with water and soap and rinse it several times. Follow the directions on the liquid fertilizer bottle to make the right solution. Shake the jug well to be sure the materials are mixed. (Another way to make the solution is to use 1 level teaspoon of Epsom salts, 1 level teaspoon of saltpeter, 1 level teaspoon of baking powder and ½ teaspoon of ammonia. Add these to an empty jug and slowly add water, shaking the jug when it is about half full and when it is full until all the chemicals dissolve.) Either of these solutions will work well to make your garden grow.



Cut off the top of the plastic jug and punch a few holes in the bottom so the solution will drain out. Fill the cut-off jug with sand and gravel or with vermiculite and plant the seeds. Place the jug in a metal pan and pour the solution into the top of the cut-off jug. BE CAREFUL NOT TO POUR MORE THAN THE METAL PAN CAN HOLD! When the solution has drained through, pour the liquid back into the bottle and save it for the next day. Repeat this each day until the seeds are sprouted and then do it only when the plants begin to dry out. Be sure the plants are put in a sunny place. If they are grown in the dark the stems will be longer and the plants will tip over easily.

Method Two

Prepare the liquid solution as in method one. Punch a few holes in an aluminum pie plate or use a TV-dinner pot-pie plate. Plant the seeds in a sand and gravel mixture or use vermiculite. The hole in the pan must be large enough for the roots to grow out. Arrange some of the gravel so all the sand does not run out. Place the metal pan on top of a cut-off plastic bottle and water each day with the solution until the roots have grown through the holes. Then place some of the fertilizer solution in the bottom bottle (leaving an air space) and the roots will grow into the solution. Replace the solution from time to time to keep it fresh.



DATA CARD
PLANT SURVEY

	HEALTHY PLANT	UNHEALTHY PLANT
Appearance (color, size, shape)		
Location of plant (near building, other plants)		
Type of Soil (see soil cards)		
Amount of moisture*		
Amount of sunlight*		
Adaptations to location (special structures; note roots, leaves, stems, etc.)		

* For quantitative measures of moisture and sunlight, see the information cards, Measuring the Microclimate of a Habitat.

the problem:

What do plant roots do?

clues for you:

Root a plant in a clear container. Secure the plant with toothpicks. Once the plant has grown roots, mark the level of the water. Cover the top of the container with cellophane wrap to prevent evaporation. Allow only the green part of the plant to be open to the air. Carefully observe and record the level of the water each day. What happens?

Read the information card, Using the Microscope. When you think you are ready, have the teacher check your operation of the microscope. Cut a small root hair from a plant. Place it on a slide. Study it under the microscope. Draw what you see. How does the structure of the root aid it in absorbing water and minerals?

Materials:
information cards, Using the Microscope (11-1), and Doing A Lot With a Little (11-3), clear container, toothpicks, plant, cellophane wrap, microscope, glass slides, paper towels, knife, rubber bands, magazines, glue, scissors, construction paper

CAUTION: Sharp knife

other ways to look at it:

.. Make a sandwich. Use two glass slides, a piece of paper towel, and a radish seed. Put rubber bands around each end of the slides. Place one end of the sandwich in a shallow dish of water. When roots start to grow, place the other end of the slide in the dish. Wait several days. What happens?

.. Can a plant survive without roots? Design an experiment to find out.

.. Make a collage. Use pictures of plant roots that are foods. What job of roots makes the food?

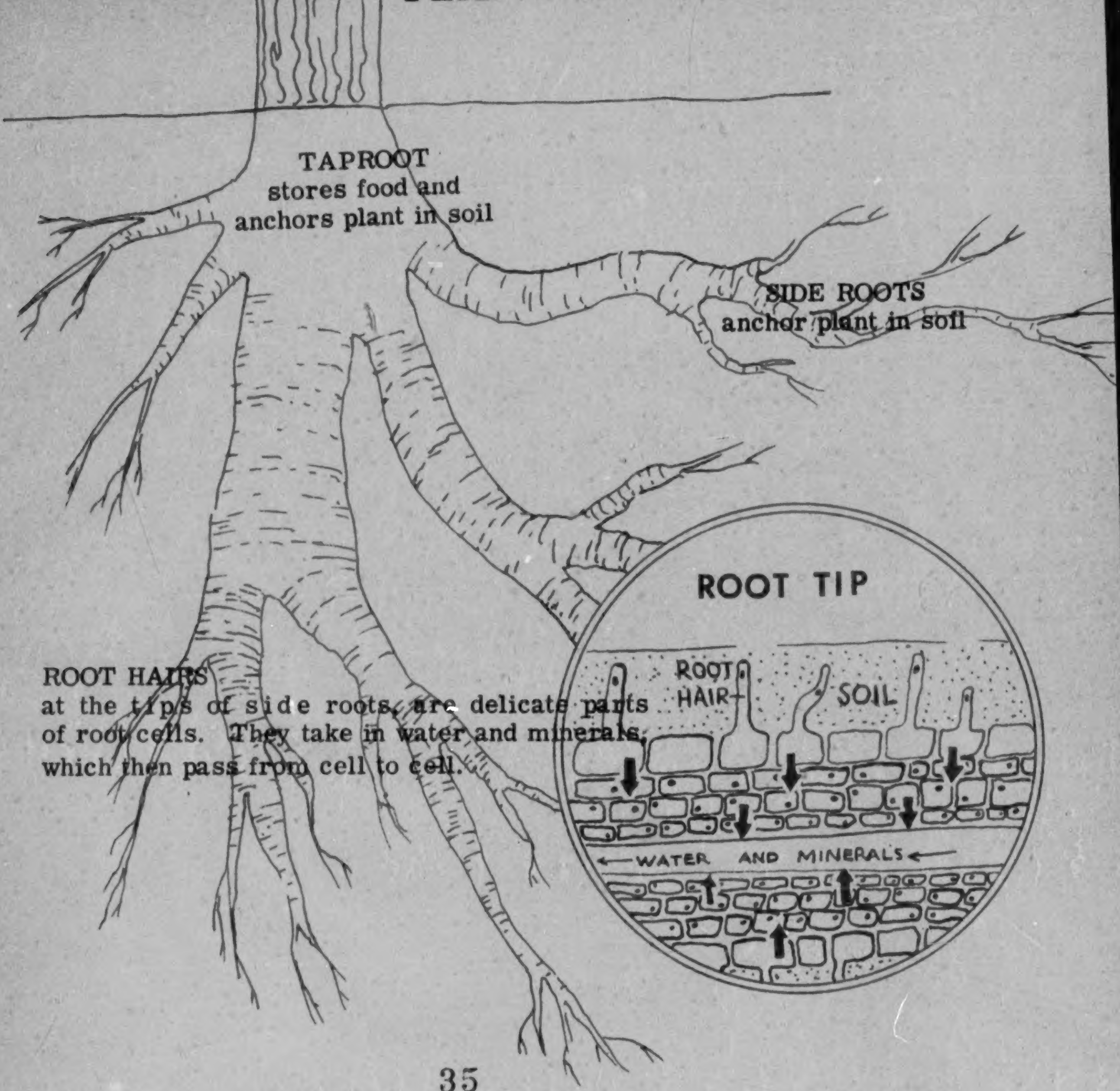
.. Read the information card, Doing a Lot with a Little. How do the roots of desert plants help them suvive in a dry environment?

.. Pull up a weed. What comes with it? Why do conservationists urge farmers to plant cover crops on land they are not using? Why is it important not to destroy vegetation on sea dunes?

what did you discover?

List three functions of plant roots.

PLANT ROOTS



TAPROOT
stores food and
anchors plant in soil

SIDE ROOTS
anchor plant in soil

ROOT HAIRS
at the tips of side roots, are delicate parts of root cells. They take in water and minerals, which then pass from cell to cell.

ROOT TIP
ROOT HAIR
SOIL
WATER AND MINERALS

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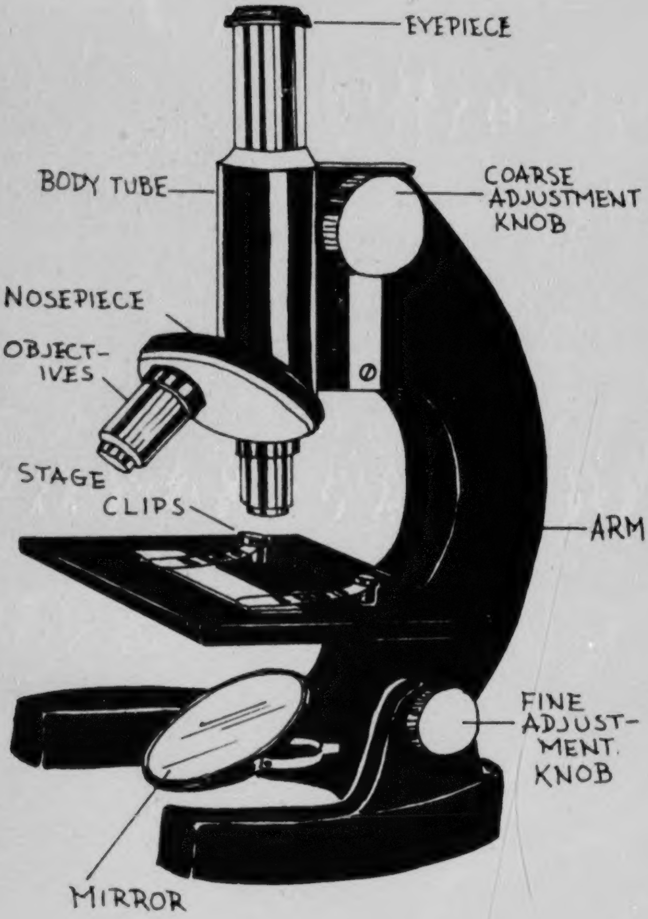
[1] "Visit to a Plant Factory," Nature and Science, September 30, 1968, p. 8.

Student Information Card

Using the Microscope



The microscope is an instrument designed to examine objects too small to be seen with the human eye. The microscope is an expensive instrument that must be given proper care. Always follow these rules when using a microscope:

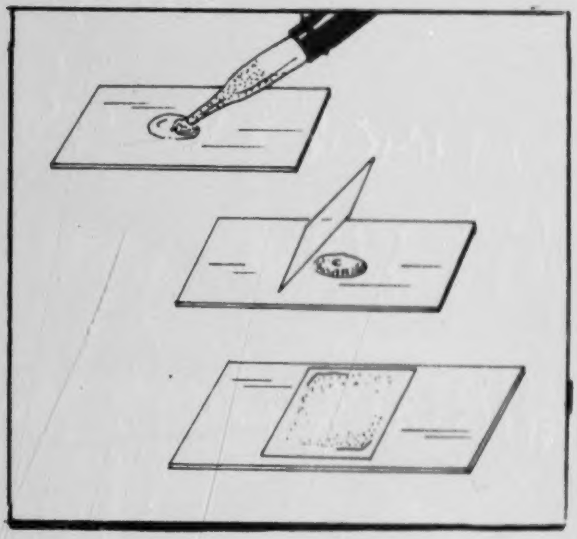
1) Always carry the microscope with both hands, one hand under the base and the other on the arm.
2) When setting the microscope on a table, keep it away from the edge of the table. If there is a lamp attached to the microscope be careful of the wires.
3) Avoid tilting the microscope when using temporary slides made with water.
4) The lenses of the microscope cost almost as much as all the other parts put together. NEVER clean them with anything other than lens paper.
5) Always return the microscope to the low-power setting and the barrel to its lowest position before you put it away.

To use the microscope, place the low-power objective in place. You will hear it click when it is properly fitted. Move the mirror so that the maximum amount of light is reflected upward through the opening in the stage. If the microscope is electric be sure the cord is plugged in and the light is working. Always start with the barrel in its lowest position and focus upward. This way you won't crush a slide or lens.

Student Information Card

Making Slides

You will need a slide, cover glass, and a dropper of water. Be sure the slide is clean.



1) Place the object to be viewed on a clean slide and drop one drop of water on the object. This is called a wet mount.
2) When the object is soaked, hold a cover slip on the slide at a 45° angle to the slide and lower the cover slip very gently. A gentle tap will usually remove any air bubbles that may be present.
3) Place the slide on the stage and clamp it down. Move the slide so the object can be seen through the eyepiece. Watch the stage from the slide while you use the coarse adjustment knob to raise the objective. Raise it until the objective is 2 mm above the slide, or the object is fuzzy.
4) Look through the eyepiece and use the fine adjustment to focus the object. Notice that the object appears upside down and backwards.

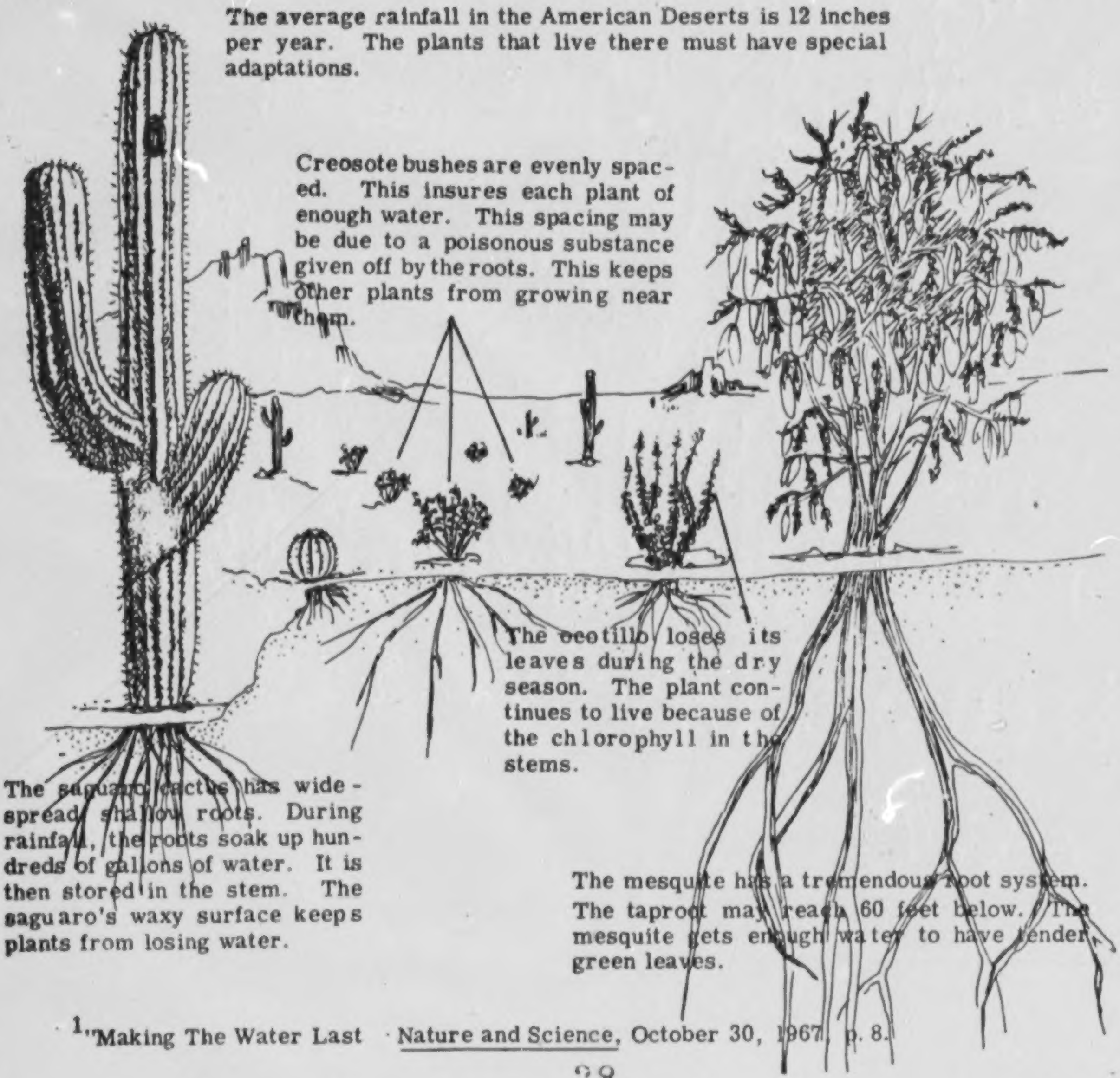
Steps for using High-Power

CAUTION: Do not change focus while changing the objectives. DO NOT focus high power with the coarse adjustment.

1) Find the object with low power.
2) Focus and adjust the light to get the best light available.
3) Position the slide so that the object is in the center of the low power field.
4) Turn the high-power objective into viewing position.
5) Sharpen the focus with the fine adjustment only.
6) If you are not successful in finding the object under high power the first time return to step 1 and repeat the whole procedure carefully.

Doing a Lot With a Little[1]

The average rainfall in the American Deserts is 12 inches per year. The plants that live there must have special adaptations.



Creosote bushes are evenly spaced. This insures each plant of enough water. This spacing may be due to a poisonous substance given off by the roots. This keeps other plants from growing near them.

The ocotillo loses its leaves during the dry season. The plant continues to live because of the chlorophyll in the stems.

The saguaro cactus has wide-spread, shallow roots. During rainfall, the roots soak up hundreds of gallons of water. It is then stored in the stem. The saguaro's waxy surface keeps plants from losing water.

The mesquite has a tremendous root system. The taproot may reach 60 feet below. The mesquite gets enough water to have tender, green leaves.

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[1] "Making The Water Last Nature and Science, October 30, 1967, p. 8.

the problem:

What do plant stems do?

clues for you:

Bring several kinds of stems to class. Examine the outside of the stem with a hand lens. Draw what you see.

Bring in the stalk of a celery plant. Place it in food coloring. Leave it for twenty-four hours. What happens? Why do you think this happened?

Cut a cross section of the celery stem. Examine it with a hand lens. Can you find any clues about what happened?

Obtain prepared slides of the cross section of a plant or read about stems. What special cells aid the stem in conducting liquids? Make a water color painting of the cross section of a stem. Show your classmates how each part of the stem aids it in its job.

Materials:

information card, Doing a Lot With a Little (11-3)
books on plants
food coloring
microscope
newsprint
plant stems
water colors
knife - CAUTION
tempra paint
prepared slides
magazines
hand lens
water color paper

other ways to look at it:

.. Do potatoes and onions have stems? Find out. You may be surprised.

.. Find pictures of stems we eat. Make a display using the pictures.

.. Dip the ends of different stems in tempra paint. Mark prints on newsprint using different stems and different colors. After the prints are dry, examine them with a hand lens. Can you see the cells in the stems?

.. Try budding, grafting, or air layering.

.. Read the information card, Doing a Lot With a Little. How is the stem of the saguaro special? How does it enable the cactus to live in its environment?

.. Why are the stems of trees important to man? What uses do they have?

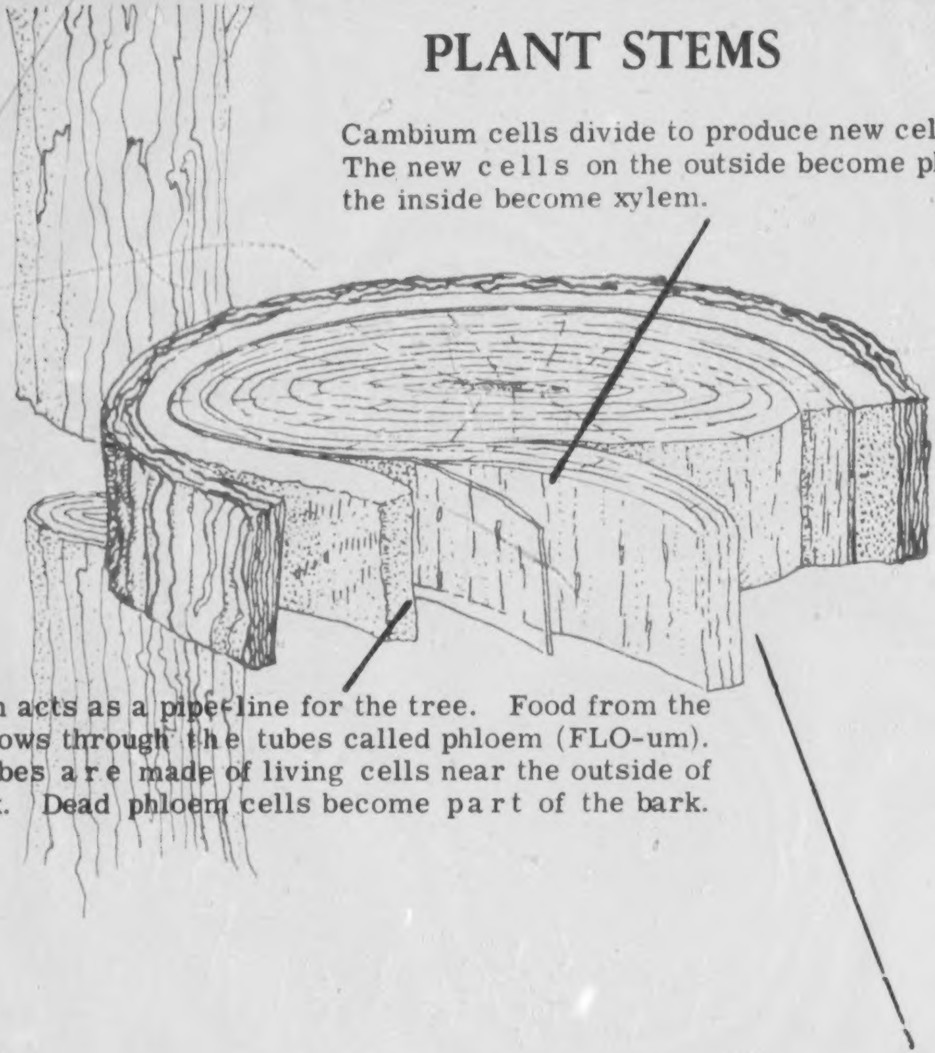
.. Find a tree stump. Count the rings. What do they tell you?

what did you discover?

Make a display to show why plant stems are important.

PLANT STEMS

Cambium cells divide to produce new cells over and over. The new cells on the outside become phloem. Those on the inside become xylem.



The stem acts as a pipe-line for the tree. Food from the leaves flows through the tubes called phloem (FLO-um). These tubes are made of living cells near the outside of the trunk. Dead phloem cells become part of the bark.

The xylem (ZEYE-lem) conducts water and minerals up the trunk. These pipes are made of dead cells and run from the roots to the leaves.

[1] "Visit to a Plant Factory," Nature and Science, September 30, 1968, p. 8.

the problem:

What is the function of a plant leaf?

clues for you:

Try this experiment. Take a little pinch of corn starch. Add it to half a test tube of water. Shake. Add a drop of iodine solution. What happens? This is a test for starch. Starch is stored food energy.

Take a green leaf that has been in the sunlight. Soak it for a few hours in alcohol. What color does the alcohol turn? What causes this? Rinse the leaf with a few drops of water. Soak it in a test tube with the iodine solution. What happens? Was starch present?

Repeat the experiment. Use a leaf from a plant that has been in the dark for at least twenty-four hours. What happens? What are your conclusions?

Materials:

leaves (see clues for you)
iodine solution
microscope
test tubes
alcohol
starch
water
slides
information cards, Using the Microscope (11-1) and the Scientific Investigator (13-1)

other ways to look at it:

.. Repeat the experiment. Use a green and white leaf. Does the white area show any evidence of starch? What is the green material? Why is it important?

.. Can a plant survive without leaves? Plan an experiment to find out. Read The Scientific Investigator before you start.

.. Study the bottom layer of a leaf under the microscope. Study a cross-section also. Use prepared slides if you have them. How is the leaf especially suited for its job?

.. Make a leaf collection. Use a leaf key to identify the leaves in your collection.

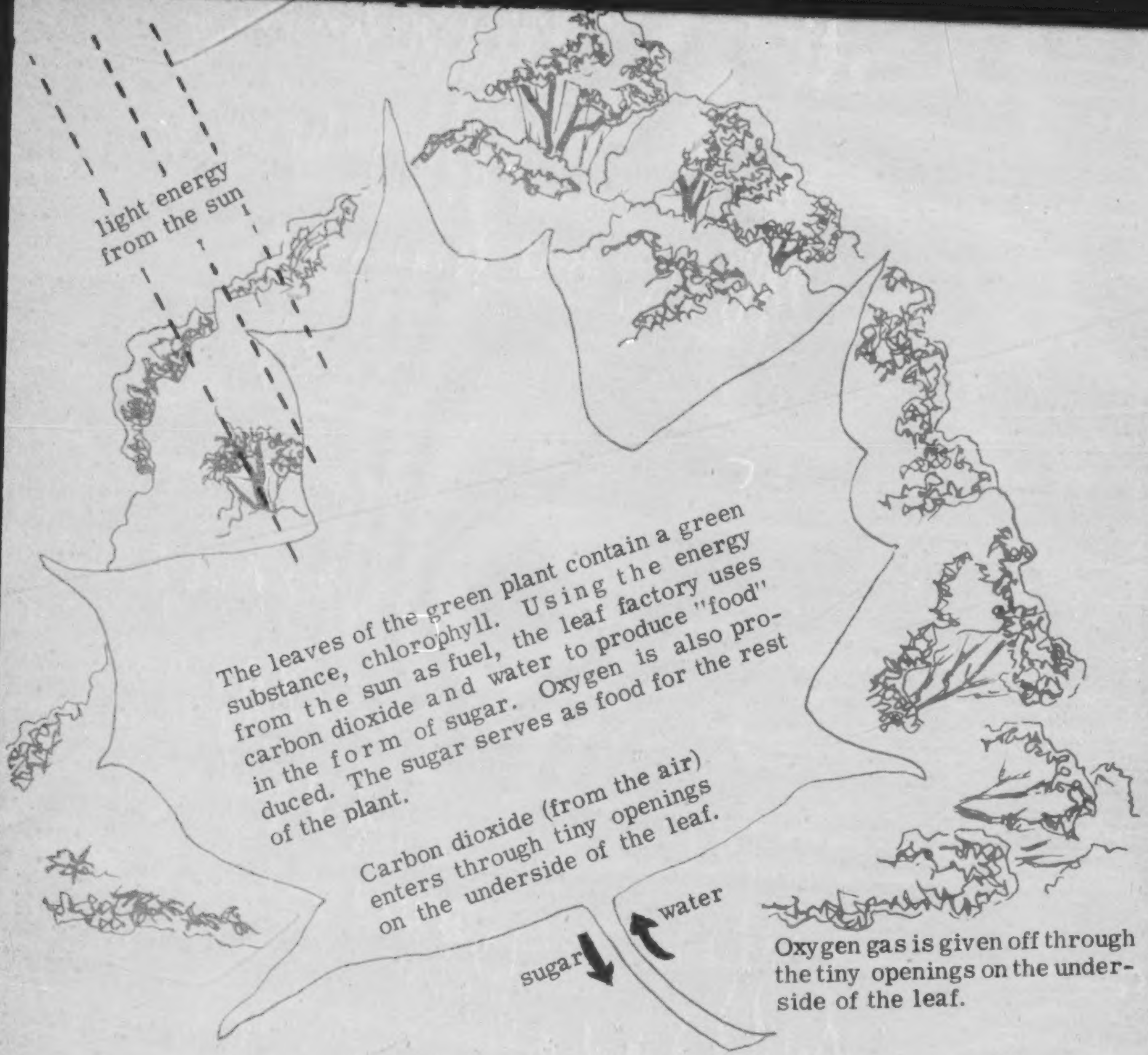
.. Make leaf prints. Your teacher has the directions.

.. Read about the carbon dioxide-oxygen cycle. What part do leaves play in this?

.. Solve this riddle: How is a tree like an air conditioner?

what did you discover?

Pretend you are a leaf. Tell the class why you are important.


light energy from the sun
sugar
water

The leaves of the green plant contain a green substance, chlorophyll. Using the energy from the sun as fuel, the leaf factory uses carbon dioxide and water to produce "food" in the form of sugar. Oxygen is also produced. The sugar serves as food for the rest of the plant.

Carbon dioxide (from the air) enters through tiny openings on the underside of the leaf.

Oxygen gas is given off through the tiny openings on the underside of the leaf.

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[1] "Visit to a Plant Factory," Nature and Science, September 30, 1968, p. 8.

INFORMATION CARD

The Scientific Investigator

In solving most problems, it is very helpful to follow certain steps to a conclusion. It helps avoid error and saves time and effort. It also brings the investigator to a more dependable or valid, conclusion. A scientist follows certain logical steps in a sequence known as the scientific method.

The famous research scientist, Louis Pasteur, once said, "Chance favors the mind prepared." Chance, or luck, has played a part in many famous discoveries. If one looks into discoveries of scientists, however, it could be seen that the investigators left little to chance. Trial and error has a place in many investigations. But the error is greatly reduced and, in fact, put to use in guiding the scientific investigator on the right track to uncovering the truth.

The scientific method in solving a problem is as follows:

Step I. STATE THE PROBLEM you are going to try to solve. It will help bring your thoughts together so you can concentrate. Many times it is put into question form.

Step II. STATE THE PURPOSE, or reason, for solving this problem. Once the value of the discovery you are trying to reach is understood, the effort will all seem worthwhile.

Step III. MAKE A HYPOTHESIS (or a reasoned opinion) about the outcome of your investigation. Put down what you think you will discover. This gives you a working idea from which suggestions about how to go about solving the problem can be taken. This will be called your experiment design.

Step IV. LIST THE MATERIALS you intend to use in solving the problem. Like a recipe for your favorite dessert, the materials needed are listed before any directions about cooking is given. This is another logical step in having a "mind prepared."

Step V. DESCRIBE THE PROCEDURE step-by-step. This is how you plan to use the materials listed above to solve the problem. This is the design of your experiment, or your plan of attack. If carefully thought out, it will leave little to chance. Remember when desinging your experiment the usefulness of a control to help prove your conclusion.

Step VI. RECORD THE RESULTS of the procedure you followed. This is where you would record your observations of any changes, or lack of change, in your experiment. Remember that you observe with all your senses; smell, hearing, tasting, feeling, as well as seeing. Be sure to note your observations or measurements immediately. This will avoid memory loss when trying to recall later what happened. Many times a drawing or sketch will help describe what you observed.

Step IV. MAKE A CONCLUSION about the results you observed. Always circle back to your hypothesis here. Was it correct? How do your results prove you were right? If your hypothesis was wrong, your conclusion should explain why. Here is a good place to suggest another experiment design to go with a revised hypothesis if you were wrong.

The Scientific Investigator

(THE SETTING IS IN THE HOME OF THE FAMOUS DETECTIVE, SHERLOCK HOLMES. HOLMES HAS JUST HUNG UP THE TELEPHONE AND TURNS TO HIS ASSISTANT, DR. WATSON.)

SHERLOCK HOLMES: Well, Dr. Watson, another mystery faces us this day.

DR. WATSON: And what's that, Holmes?

HOLMES: (HE STATES THE PROBLEM) We must find out who has stolen the Duke's jeweled medallion.

WATSON: Why must we do it? Why can't the police, or Scotland Yard find out?

HOLMES: (HE STATES THE PURPOSE) The Duke has been a close friend of the family for years. Lately he has been having financial problems. He cannot afford such a loss at this time. Besides, the police and the Yard are baffled and have been unable to crack the case.

WATSON: You've talked to the police and the Duke already. Do you have any clues or idea who the culprit is?

HOLMES: (HE MAKES A HYPOTHESIS) Well, Watson, from what I have learned thus far, it seems to have been an inside job. It was not a break-in burglary. I presume the thief to be employed by the Duke, perhaps as one of his many servants. He had to have detailed knowledge of the house and of the medallion. Let's get our things together now, Watson. The Duke has invited us to be his guest until we can solve this mystery.

WATSON: I'll pack the magnifying glass and the fingerprint kit. Is there anything else we'll need?

HOLMES: (HE DETERMINES THE MATERIALS AND EQUIPMENT HE'LL NEED) Yes, Watson. We'll need my diamond-studded cuff-links and tie-pin. Also, bring along your revolver. The Duke was assaulted during the robbery. This must be the work of a desperate brute. We may need it in the course of the investigation.

(DR. WATSON PACKS THE EQUIPMENT INTO A SMALL BLACK LEATHER BAG. THEY LEAVE THE HOUSE, ENTER A WAITING CARRIAGE, AND START FOR THE DUKE'S MANSION OUTSIDE LONDON.)

WATSON: What's your plan, Holmes? I can understand the fingerprint kit and even the gun. Your personal jewelry has me confused. Is this to be a formal affair?

HOLMES: (HE STATES THE PROCEDURE) Hardly, Dr. Watson. The police have thoroughly questioned all the servants. They have come to no conclusions about who the thief is. I shall play the thief's game. Sometimes to catch a criminal one must think like one. If the culprit has the idea that the police have given up, he may consider himself in the clear. He will be ready to try again. This is the way of greedy men. I expect to give the chance and lay a trap for our man. Oh, here we are, Watson. The Duke's mansion. Let's go in.

(THEY ENTER THE MANSION, GREET THE DUKE, AND HOLMES' INTRODUCES DR. WATSON. THE THREE THEN DISCUSS HOLMES' PLAN TO CATCH THE THIEF. THE DUKE CALLS ALL THE SERVANTS TOGETHER AND TELLS THEM THAT THEY ARE ALL FREE TO GO ABOUT THEIR BUSINESS AS THE POLICE ARE LOOKING ELSEWHERE FOR THE BURGLAR. HE THEN INTRODUCES HOLMES AND WATSON AS HOUSE GUESTS. ALL THE WHILE THE DUKE WAS TALKING, HOLMES WAS PLAINLY FINGERING AND TOYING WITH HIS DIAMOND CUFF LINKS AND MATCHING TIE-PIN. AFTER THE MEETING WITH THE SERVANTS, WATSON AND HOLMES GO TO THEIR ROOM.)

WATSON: What the devil were you doing, Holmes? All the time the Duke was talking, you kept drawing attention to yourself. You were playing with that jewelry of yours. It seemed very impolite. Very impolite, indeed!

HOLMES: (HE REPORTS HIS OBSERVATIONS) Maybe so, Watson. But rather than watching me you should have been watching the eyes of the servants. Certainly all eyes were on me and my jewelry for a few moments. Only one pair of eyes stayed fixed on them. They brightened when the Duke reported that they were all in the clear. I checked with the Duke about this person. I was told that he is a heavy gambler. He always asks for advances on his wages to pay for gambling losses. I also have found his fingerprints near where the Duke kept his medallion. Now all we have to do is wait.

WATSON: Wait for what? It's time to turn in, Holmes. It's getting late. Where are you going now?

HOLMES: Come on, Doctor. Bring along your revolver. I have put my cuff links and tie-pin in the cabinet where the Duke kept his medallion. We'll have to get ready to spring our trap.

(THEY QUIETLY TAKE UP STATIONS IN THE DUKE'S DEN WHERE THE CABINET STOOD. IT WAS DARK IN THE ROOM AND THE MOON'S FEEBLE LIGHT THROUGH THE WINDOW GAVE AN EERIE GLOW. THE CLOCK IN THE ROOM CHIMED MIDNIGHT, THEN 1 A.M. SUDDENLY A NOISE! SOMEONE HAD ENTERED THE ROOM!)

HOLMES: Now, Watson! Turn on the lights!

WATSON: Why, it's Smith, the butler. With a key and everything. I've got him covered, Holmes. Call the police.

(THE SURPRISED BUTLER RAISED HIS HANDS. THE DUKE ENTERS THE ROOM, WEARING HIS NIGHT CLOTHES, FOLLOWED BY SEVERAL SLEEPY-EYED SERVANTS.)

HOLMES: Unfortunately, Watson, you are pointing the gun at the wrong person, isn't he Duke?

WATSON: What do you mean? If Smith here isn't the man we want, why was he going for the cabinet in the middle of the night? And who is the thief?

(THE BUTLER BREAKS DOWN AND CONFESSES THAT HE FOUND THE KEY TO THE CABINET ON THE DUKE'S DESK AND TOOK IT WITH THE INTENTIONS OF STEALING THE CUFF LINKS AND TIE-CLASP TO HELP PAY FOR GAMBLING DEBTS.)

WATSON: There, Holmes, you're wrong. Smith here is the one we want. He tried to steal your jewelry and stole the Duke's medallion.

HOLMES: (HE MAKES HIS CONCLUSION) You're partly right, Watson. Smith did try to steal my jewelry. It was the Duke that made it easy for him by leaving the key out. The Duke knew that Smith needed money to cover gambling losses. Because the Duke himself had gambling debts. Smith never told the Duke why he needed those salary advances. The Duke knew the advances were also very small, five or ten pounds each time. There was no need for the butler to steal a medallion worth a fortune to pay off such small debts. But the Duke had run up very heavy debts. I found out he had taken out several loans. There was pressure on him to make good on them. So the Duke sold his own medallion, injured himself, and reported it stolen to get the insurance for it. He had hoped to pin the blame on Smith here by encouraging the theft of my cuff links and tie-pin. This would throw full suspicion on the butler and put himself quite in the clear. Call the police indeed, Dr. Watson. We have our Man!

the problem:

What special features for survival do plants have? (Another word for these special features is adaptations.)

clues for you:

Find a cactus or other succulent plant (Succulent plants are those which have fleshy tissues for conserving moisture). Cut into the stem and examine it with a hand lens. Cut a section of the root system. Observe it through a hand lens. A drop of ink or dye may help you.

How do the stem, roots, and leaf blades store water?

What are its defenses against animals?

How does this plant reproduce?

How does the skin of this plant help it fit the description of a "vegetable camel?"

How did the plant protect itself from you?

Materials:

succulent plant, such as cactus, aloe
sharp knife
hand lens
ink (or dye)
construction paper

CAUTION:
Juices from plants may cause minor burning. Wash your hands with cool water.

other ways to look at it:

.. The mangrove is a very unusual plant. It grows in shallow water. Find out how it is adapted for survival. How does it aid in the formation of new land?

.. Locate a common weed. Pull it up. Look at it closely. What structures aid it in surviving? Why is it considered a weed? How is it usually destroyed?

.. Read about the plants of one different area, such as the chaparral, the tundra, or the tropics. How do their adaptations differ? Could they survive in this environment?

.. Sketch a plant that is abundant in your area. With labels, show how it is especially adapted for life in your area. Could it survive in a different environment? Where else would you expect to find it growing?

.. Write a riddle about a local plant. Mention at least two of its adaptations. Try to stump your friends.

what did you discover?

Make a chart. Show the special adaptations of at least one plant you examined or read about. Include a description of the environment for which this plant is adapted.

the problem:

What does the soil in your area look like?

clues for you:

Read the card, Constructing a Soil Profile. After you understand the directions, gather your equipment and go outside. Follow the directions for making a soil profile. Repeat this activity in several different locations. Try to select areas where the soil will be different. Tag the samples you collect.

After you have constructed your soil profiles, compare them. Are they like the one on the cover? How is the soil in your area different? How was the soil from each location different?

Study the card Soil Profile Chart. What can you find out about the soil in your area from this chart? Report to the class about your soil.

Materials:
information cards, Constructing a Soil Profile (15-1) and Soil Profile Chart (15-2)
glass containers
shovel
1" cards, glue, plastic bags

other ways to look at it:

.. Do the other activity cards on soil (16, 17). Write a short report about what you learned.

.. Based upon your findings, decide what the soil in your area is good for. What uses would you suggest for this land?

.. Invite someone from the Soil Conservation Service or your county agent to the class. Ask him to help you test the soil on your campus. Have him suggest the type of plants that will grow there. Try planting one of them.

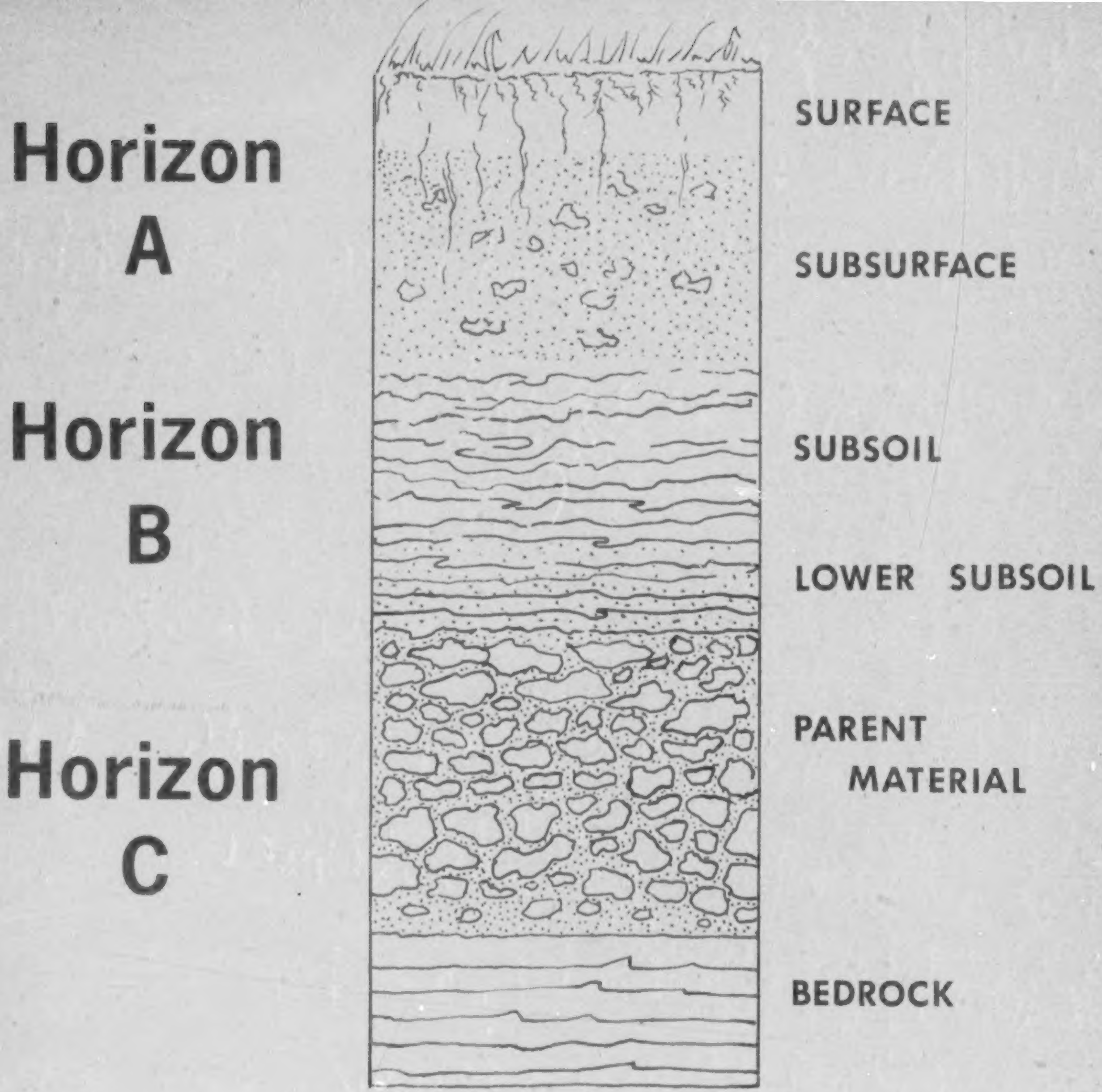
.. Find out how scientists use the information in a soil profile.

.. This study did not take into account the animals living in the soil. Do they make a difference in the quality of the soil?

.. Make a three dimensional soil profile. Use your soil samples and a glass container. Have your friends study the soil colors and texture. What can they tell you about the soil?

what did you discover?

Post your soil profiles for the rest of the class. Tell your classmates what you found out about the soil in your area.


Horizon A
Horizon B
Horizon C
SURFACE
SUBSURFACE
SUBSOIL
LOWER SUBSOIL
PARENT MATERIAL
BEDROCK

CONSTRUCTING A SOIL PROFILE

One of the best ways to communicate your discoveries about the soil in your area is by constructing a soil profile. A soil profile is really a cross-section of the soil, showing each layer. A typical soil profile is shown on the front of this activity card. Soil profiles may differ from area to area. Each layer in the soil profile is called a horizon. Each horizon represents a different kind of soil.

You can construct a profile of the soil in your area. It will show you the depth of different types of soil. Start by digging down several feet in the soil. Make a V-shaped cut so that one side of the soil if left exposed. Record the depth of each layer. Use the area at the left of this card for this. Draw in the layers. Take a sample from each layer. Place it in plastic bags. Feel and record the texture of each layer. Note the surrounding of the area (open field, wooded area, beach).

Return to the classroom. Using the notes and the samples, construct a minature of what you saw. You can do this several ways. One way is by gluing the sample to a 1" by 1" card. Mount the cards on a poster, identifing each layer.

A second way is by displaying the samples in jars, estimating the depth of each layer.

SOIL PROFILE CHART

Your soil profile can tell you a great deal about the soil. Scientists start by looking at the colors of the different layers. The charts below show how color is related to different features of the soil.

I. Some Relationships of Color to Soil Conditions

A. Topsoil (This is the top layer of soil on your soil profile.) The chart below lists some of the features scientists are interested in. Organic material is the remains of plants and animals still in the soil (see card #16). The more organic material the soil has, the richer looking it is. Scientists are also interested in the erosion factor. This tells them how quickly the soil will wash away. Aeration tells you how much air is mixed in with the soil. Nitrogen is an element that plants need for growth. Fertility means how well the soil will grow plants.

FACTOR	COLOR		
	Dark (dark grey, brown to black)	Moderately Dark (dark brown to yellow brown)	Light (Pale brown, to yellow)
Amount of organic material	excellent	good	low
Erosion factor	low	medium	high
Aeration	excellent	good	low
Available Nitrogen	excellent	good	low
Fertility	excellent	good	low

1. Using the chart above, complete the following for your soil sample:

a. amount of organic material ____________________

b. erosion factor ____________________

c. fertility ____________________

B. Subsurface Soil Color

The subsurface is the second layer on your soil profile. Its color indicates to scientists how well the soil will drain.

Subsurface Soil Color (B Horizon)	Condition
Dull Grey (if in low rainfall soils)	Water-logged soils, poor aeration
Yellow, red-brown, black (if in forest soils)	Well drained soils
Mottled grey (if in humid soils)	Somewhat poorly to poorly drained soils

What can you say about the drainage in your soil, based upon the color of the subsurface soil? ____________________

II. Effect of Texture

Scientists also look at the texture of the topsoil and subsoil. The texture indicates the water holding capacity and the looseness of the soil.

Texture	Water Holding Capacity	Looseness of Soil
Sand	Poor	Good
Silt	Good to excellent	Good
Clay	High (plants can't use it in clay)	Good

My soil texture	Soil water-holding capacity	Looseness
Topsoil (A)		
Subsoil (B)		

III. Effect of Soil Depth

The soil depth tells scientists how well the soil will support plant growth. It also indicates how well the soil will hold water.

IV. Effect of Soil Depth on Plant Growth and Water Storage

Deep Soil (over 42")	Excellent water storage and plant growth
Mod. Deep Soil (20" - 42")	Good water storage and plant growth
Shallow Soil (20" & under)	Poor water storage and plant growth

The potential of my soil for water storage and plant growth is:

excellent _____ good _____ poor _____

Why? ____

____

Adapted from: Investigating Your Environment. Portland, Oregon: U. S. Forest Services

the problem:

What organic materials are in the soil?

clues for you:

Organic materials are materials that have come from living things. These materials make the soil richer.

Go to a wooded area. Predict what things you will find in the top few inches of this area. List your predictions.

Stake out an area 1 ft. by 1 ft. on the ground. Sift through the top 3 inches of soil, recording the evidence of plants and animals you observe. Your teacher has a chart. Complete the chart.

Would you expect to get the same results in a different area? Repeat the investigation in an area that looks different. Compare your charts.

Materials:
Data Card (16-1)
string, 4 stakes, tempra paint, sponge, newsprint, small bags for samples, construction paper, scissors, masking tape

other ways to look at it:

.. Discuss: Did you find anything that surprised you? Did you expect to find some things that you did not find?

.. How does each of the organisms you found help the soil?

.. What are some reasons for odors in the soil?

.. Find out why the amount of organic materials in the soil is important.

.. Make a display of what you found. Start by spatter-painting or sponge-painting a background. Use brown tempra. Make cutouts of the things you found. Use cut-out words and drawings. Attach them to the background with a loop of masking tape. Stand far off. Can you tell what is in your soil? Look closely. Can you tell now? How is this like your investigation of the soil?

what did you discover?

Post your completed charts. Compare the results for the areas you investigated. Discuss the differences.

LITTER-DUFF-HUMUS-LITTER-DUFF

-HUMUS-LITTER-DUFF-HUMUS-

LITTER-DUFF-HUMUS-LITTER-DUFF

ORGANIC MATERIALS SURVEY DATA CARD

Name or Description of Item in the Soil	Quantity	Possible Effect on Soil

The following three terms are used to describe organic matter at the top of the soil - litter, duff, humus. From your study above, complete the following chart:

Term and definition	Describe the feel	List the identifiable parts of plants and animals you found
Litter (identifiable dead things on surface)		
Duff (partially decayed organic matter)		
Humus (almost completely decayed non-identifiable organic matter)		

Reference:

Investigating Your Environment. Portland, Oregon: U. S. Forest Service.

the problem:

What are the non-visible differences in each soil layer?

clues for you:

Some of the non-visible differences in the soil include temperature, pH, and bacteria type and amount. Try measuring at least one of these. You can use the samples you collected for the soil profile.

Record the temperature of each layer to the nearest degree.

Place a small amount of the soil sample from each layer in a test tube. Fill half-way with distilled water. Shake. Allow to settle. Test the water with pH paper. Record.

Take soil samples from each layer. Use a cotton swab. Rub it in the soil and then on to a petri dish with nutrient agar. Do one for each layer of soil. Check the culture each day for a week.

Materials:

pH paper
distilled water
test tubes
nutrient agar
petri dishes
thermometer
plastic bags
chart, Non Visible Soil Differences (17-1)

other ways to look at it:

.. A plant's growth depends upon the soil temperature during the growing season. Find out the growing season for your area.

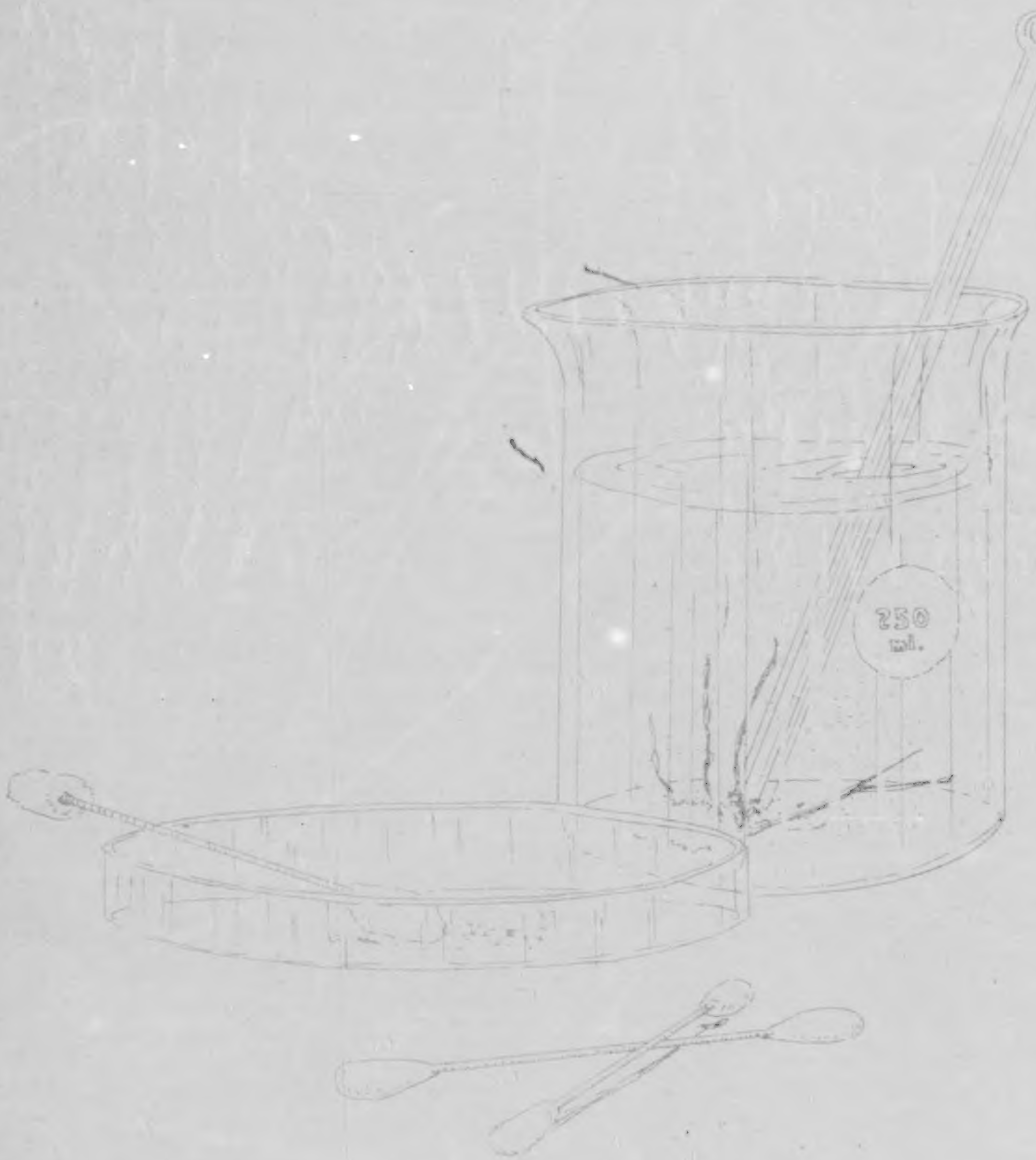
.. pH is a measure of how basic or acidic the soil is. Each plant will grow in certain type soil. Read about the plants in your area and the type soils they need. Find out how to make a soil more acidic or basic.

.. Soil bacteria are very important. Find out what they do. What are some things that might kill soil bacteria?

.. Your county agent will test the soil to find out what nutrients it contains. Many people fertilize without knowing what the plants in their area need. Find out about natural fertilizers. What harm does it do to over-fertilize your soil?

what did you discover?

Make a report to the class on one of the studies you did. Explain why it is important to know about that one factor.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STUDENT DATA CARD NON-VISIBLE SOIL DIFFERENCES

Adapted from: Investigating Your Environment
Portland, Oregon: U.S. Forest Services

Soil Temperature

Soil temperature	Conditions during growing season
Less than 40° F	No growth, soil bacteria and fungi not very active
40° F to 65° F	Some growth
65° F to 70° F	Fastest growth
70° F to 85° F	Some growth
Above 85° F	No growth

pH

1 4.5	6.5 7	8.5 14
(1 to 4.5 is too acid for most plants	(Most plants do best here)	(8.5 to 14 is too alkaline for most plants)

Example of plants in pH range:
pH 4.0 - 5.0: rhododendrons, camellias, azaleas, blueberries, fern, spruce
pH 5.0 - 6.0: pines, firs, holly daphne, spruce, oaks, birch, willow, rhododendron
pH 6.0 - 7.0: maple, mountain ash, pansy, asters, peaches, carrots, pines, firs
pH 7.0 - 8.0: beech, mock orange, asparagus, sagebrush

Using the pH ranges you recorded and the table, "Examples of Plants in pH Range," complete the following chart:

Some Plants That Could Grow Here Based on the pH Chart	Some Plants Actually Observed Growing Here

the problem:

Animals adapt to changing seasons in several ways. Find out about the way one animal adapts.

clues for you:

Bring a frog or toad to class. Place it in a large jar. Take the temperature of the air in the jar. Count the frog's pulse rate by watching his throat. Record both.

Place the jar in a large pan of water. After a few minutes, record the temperature of the jar and the frog's pulse rate. Repeat this at two-minute intervals. Continue measurements until the temperature stops dropping.

What has happened? What caused the frog's pulse rate to change? How does this help the frog survive in colder weather?

This experiment simulates hibernation. What other animals hibernate during the winter?

Materials:

pencils	paper
ice	reference books
large jar	pan
frog or toad	thermometer

other ways to look at it:

.. Find out how the animals in your area adapt to changing seasons. Research one local animal.

.. Draw pictures of animals during the winter.

.. Write a poem about an animal's adaptation to seasonal changes.

.. What do people do when seasons change?

.. Find out what the word estivate means. Try to make a list of animals that esitvate. Can you find any animals in this area that estivate?

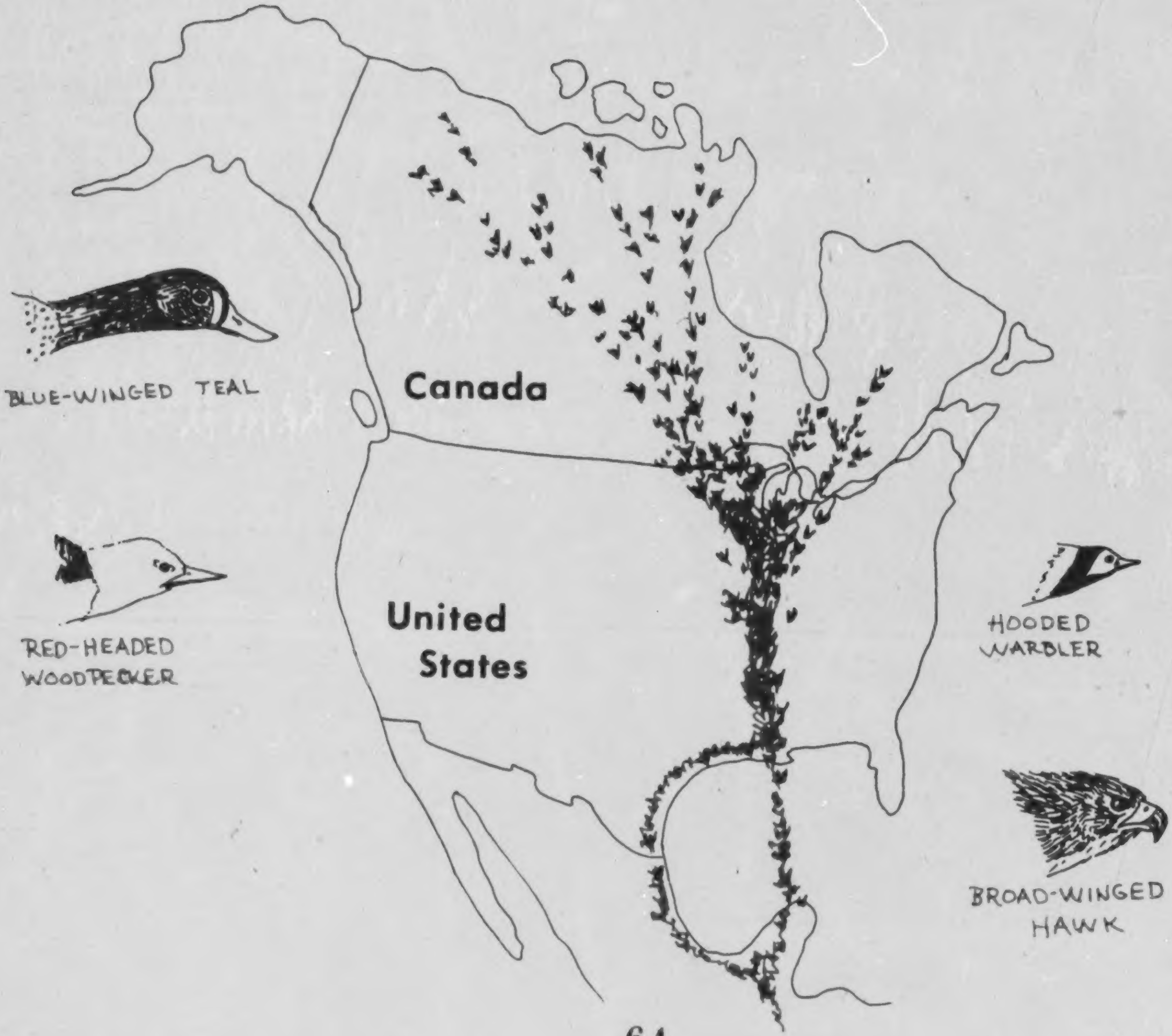
.. What does the word migration mean? What evidence of migration can you see in your area?

.. Collect pictures of animals. Divide them into groups according to the way each reacts to changing seasons.

what did you discover?

Report to your class on how one animal adapts to seasonal changes.

Mississippi Flyway


BLUE-WINGED TEAL
Canada
United States
RED-HEADED WOODPECKER
HOODED WARBLER
BROAD-WINGED HAWK

the problem:

How do adaptive structures of aquatic animals compare? (Aquatic animals are animals that live in water.)

clues for you:

Compare four aquatic animals that live in the same area (examples: blue crab, catfish, horseshoe crab, sea urchin). Try to make as many first-hand observations as possible.

Make a chart to help you. Find out the following things about each animal:

How does this animal see?
How does this animal move?
How does this animal obtain food?
How does this animal protect itself?
How does this animal breathe?

Materials:
colored pencils
construction paper
pictures of specimens of local aquatic animals
information card, Niches (51-1)

other ways to look at it:

.. Compare the skeletons and shells of these animals. If any flesh remains, boil it away. Mount and shellac the skeleton or shell. What information about the animal can you get from the skeleton?

.. The horseshoe crab is called a living fossil. Find out why.

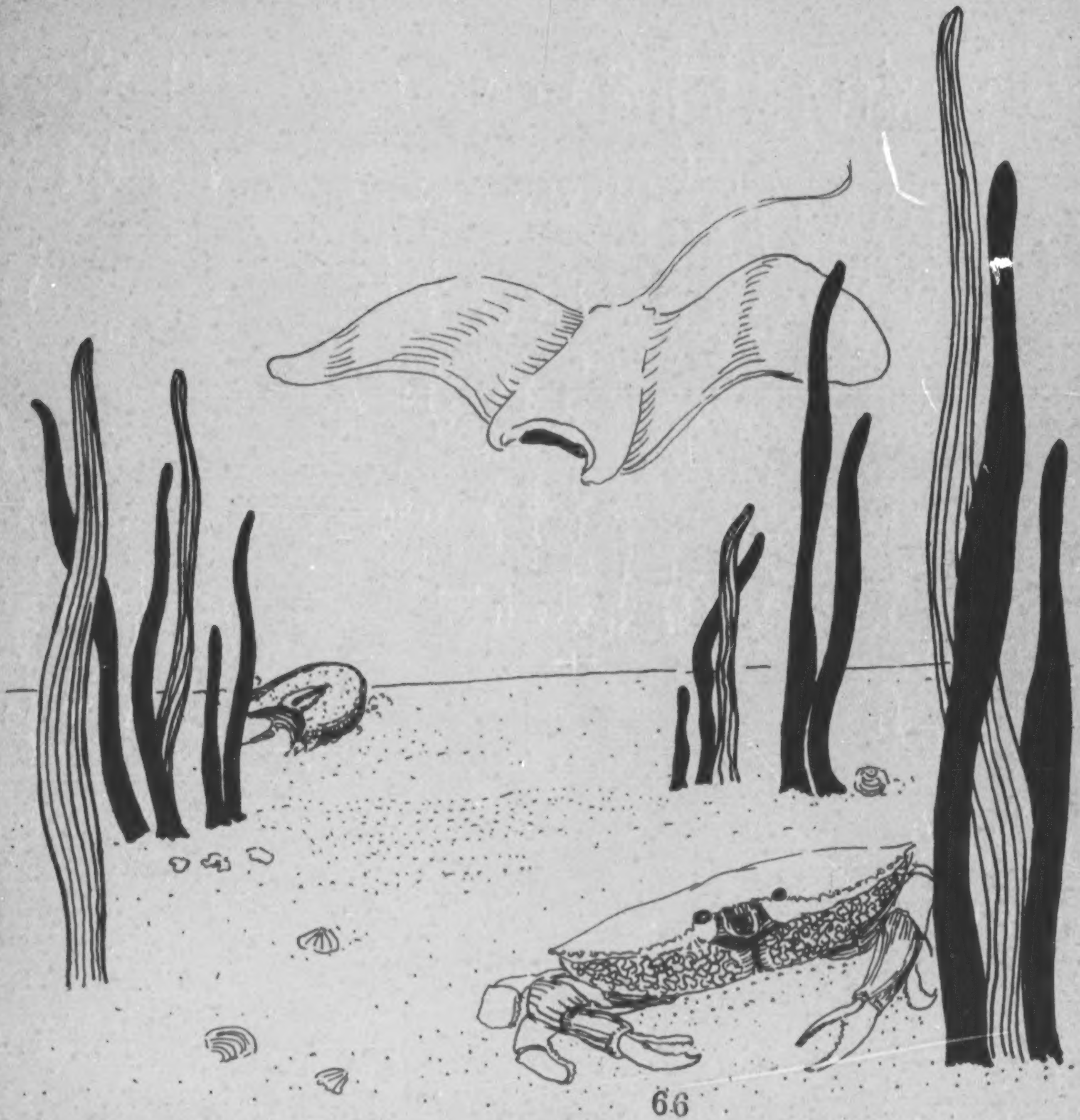
.. The blue crab and the catfish are both considered scavengers. Find out why scavengers are important. (Read the information card, Niches.)

.. How do these four animals relate to one another? Are any of these economically important to your area? Are there any threats to their survival?

.. Try this study again with four animals that live on land. Compare them in the same ways.

what did you discover?

Display your chart. Compare it with the results your classmates got.



the problem:

How are the animals in your area suited to a particular habitat? (If you aren't certain just what a habitat is, read the information card Habitats.)

clues for you:

Select a habitat in your area. Begin by describing the habitat. Observe at least two animals from that habitat.

Keep a record of your observations. Note all details on structure and behavior that fit these animals to their environment. Take or draw pictures whenever possible.

Which activities of these animals (search for food, nesting, traveling) seem to be directly affected by the environment? How?

Make a model or draw a picture of the habitat and the animals. Show how each animal is adapted for life in that habitat.

Materials:
information cards, The Survivors (57-1)
and Habitats (20-1)
pencil and paper, twigs, glue
cardboard, water colors

other ways to look at it:

.. Would these animals be able to survive in a different habitat? Predict where else they might be found.

.. What would happen to these animals if the habitat changed drastically? What things are happening in the community that might cause the habitat to change?

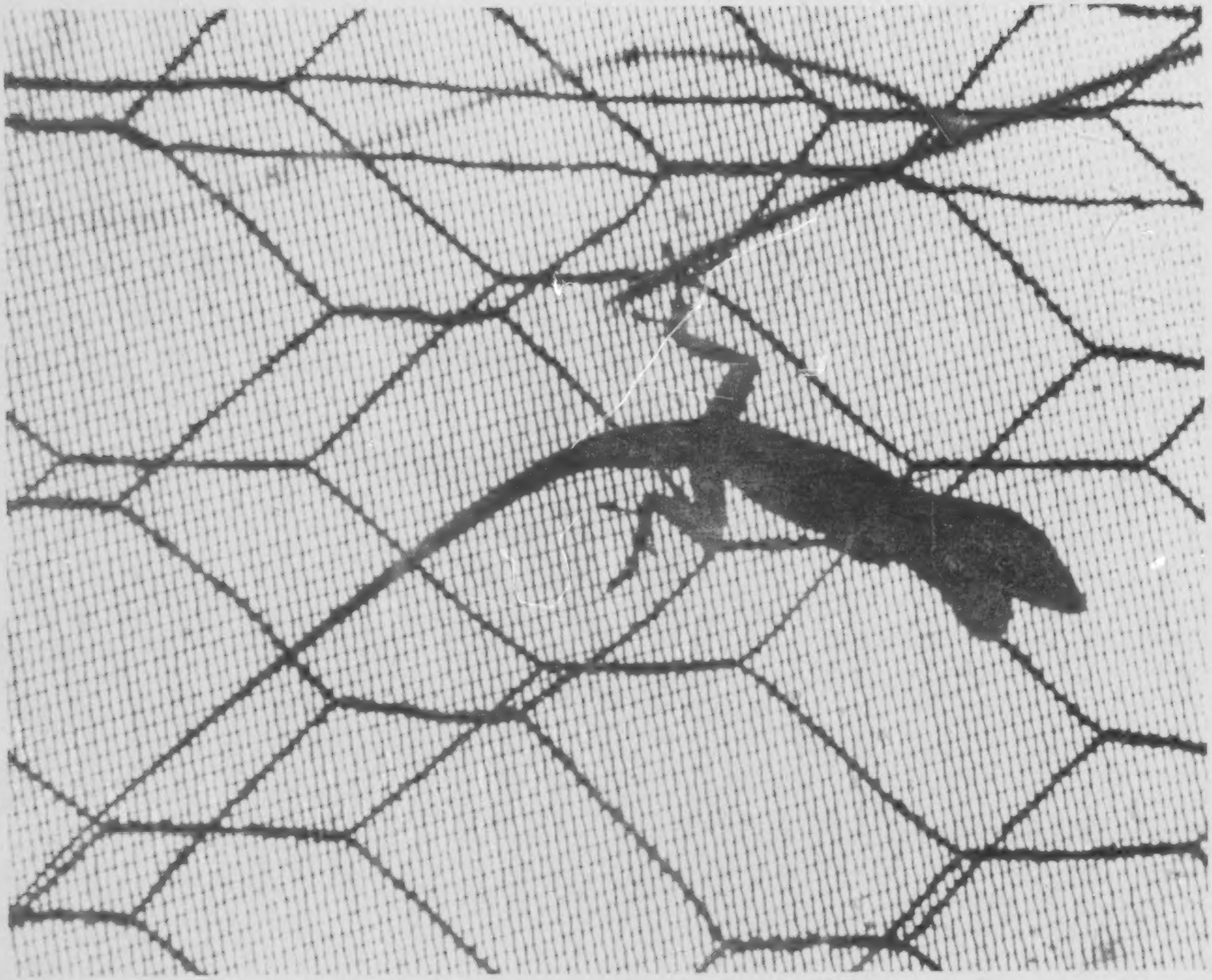
.. How can the destruction of a habitat cause an animal to become extinct? Read The Survivors. Report to the class.

.. Research one animal that does not live in your area. Point out reasons this animal is not suited for life in your environment.

.. Make mini-habitats for display in your class. Use a real plant or a model. Draw pictures of animals that might live in that habitat. Mount the pictures on cardboard. On the back of the picture, add a list of the animal's adaptations to that environment. Attach the animal to a twig. Place it in the habitat.

what did you discover?

Prepare a display on the animals you studied and the habitat in which they were found. Include a diary of observations and sketches, photographs, or models of the animals studied.



INFORMATION CARD

Habitats

Plant and animals depend upon each other in many ways. They live together in communities. Within these communities, each plant and animal lives naturally in a certain place. That place is its habitat. A habitat has all the conditions the plant or animal needs to live. There it has the right kind of climate, food, water and shelter it needs to survive. We say that the plant or animal is adapted to that habitat.

There are as many different kinds of habitats in each community as there are kinds of plants and animals living there. In a woodland community of plants and animals, you might find an earthworm living in the ground. The ground is the earthworm's habitat. You might also find a woodpecker living nearby in a tree. The tree is its habitat. If the earthworm and the woodpecker changed places, each one would soon die. Neither one is adapted to live in the habitat of the other.

Habitats may be very small, as in the case of the earthworm, or they may be very large. A hawk soars over a whole woodland community to find the food, water and shelter it needs. In his case, the entire woodland community is his habitat.

There are also habitats within habitats. The hawk's habitat may be a whole woodland. The habitat of a chipmunk might be just a few square yards on the same woodland floor. The chipmunk can get its food, water and shelter in a much smaller area than the hawk can.

Here are some questions you might want to ask yourself as you investigate habitats. Does a little change in temperature make a difference in the type of plants that will grow? Does the amount of light make a difference in what lives there? How important is soil? Is there a difference between the organisms that live in places that are wet or dry?

Miller, Shirley. The Story of Ecology. New York: Nat'l Audubon Society

Habitats

VOCABULARY

1. communities: groups of animals or plants living together
2. habitat: place where a given plant or animal lives
3. adapted: fitted, or adjusted to

the problem:

How can the fright distance of an animal be measured?

clues for you:

Gather your equipment. Go for a walk around your school or home. When you sight an animal, try to identify it. Walk slowly toward it. Make a mental note of the exact location of the animal. The moment the animal moves, drop the cloth marker. Walk to the spot where the animal was. Measure the distance back to the cloth marker. This is the fright distance.

Repeat this activity at least three times. Be sure to use an animal of the same species. Record your data on a chart.

Pick animals of other species. Compare the fright distance. Compare your data with that of your classmates.

Materials:
white cloth (handkerchief size) for marker
100 foot tape measure
clipboard pencil and paper
information card The Scientific Investigator (13-1)

other ways to look at it:

.. Can the fright distance of an animal be changed? Become familiar with one animal in your neighborhood. Measure the animal's fright distance. Design an experiment to see if you can change the fright distance. (Read the Scientific Investigator before you start.) Report your conclusions to the class.

.. How would whistling or shouting change the fright distance? Try it.

.. How does timidity help protect an animal?

.. Make sketches of the animals you studied.

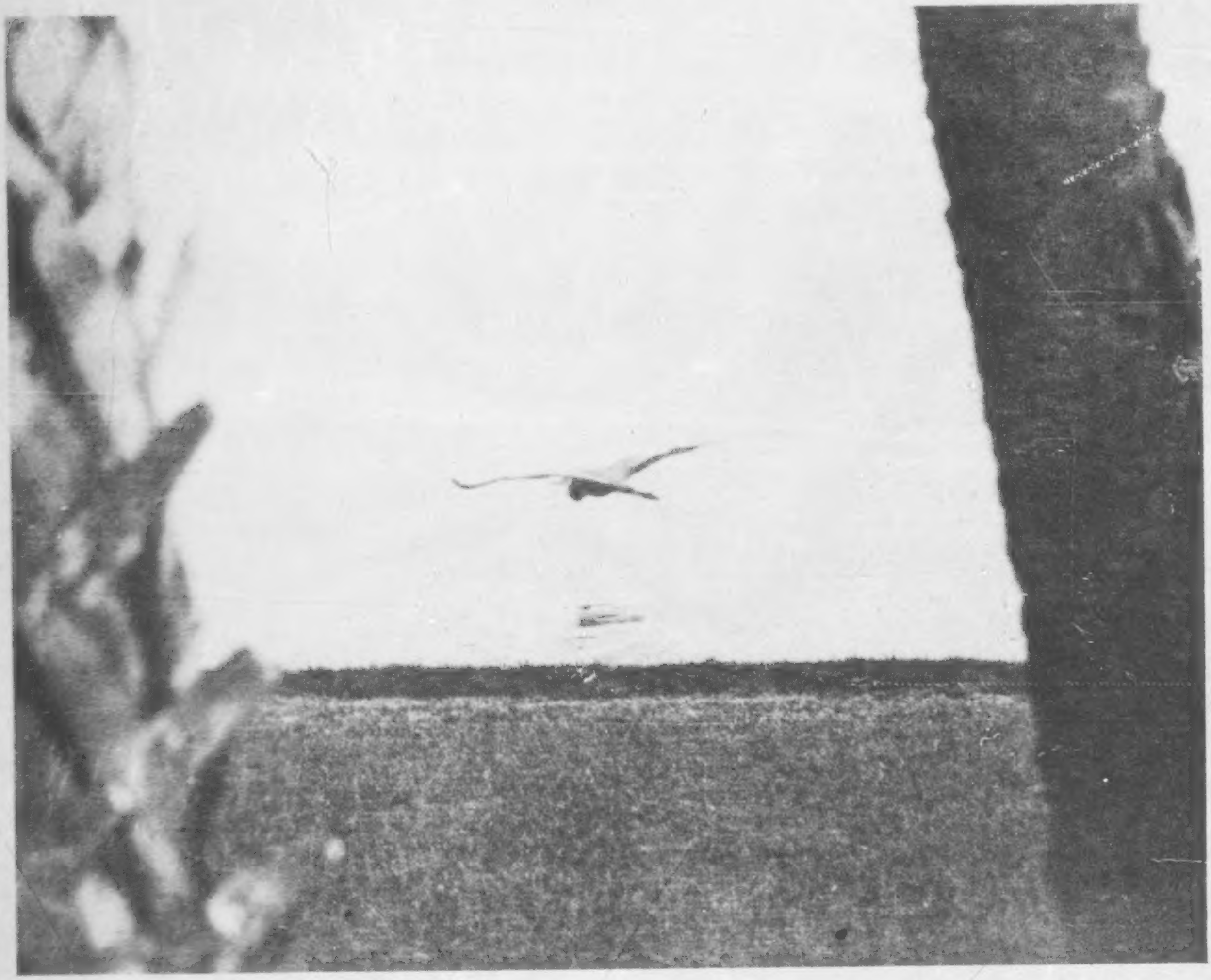
.. Repeat your experiment. This time try it with birds or small mammals in a public area. A park is a good place to start. Do these animals have a high or low fright distance? Why do you think this is so?

.. Discuss: the fright distance of an animal is an inborn characteristic.

.. Write a cinquain about one animal observed.

what did you discover?

Make a fright distance chart. Average the distance of each species after several measurements. Make conclusions about the timidness of various species. Arrange the species on your chart according to timidness.



the problem:

What special adaptations do birds have?

clues for you:

Research the following birds:

Brown pelican
Great blue heron
American egret
American coot

What things do all these birds have in common? How do each of these birds differ? Find out something about the habitat of each bird. How is each adapted to its habitat?

Find out about the diet of each of the birds. Does the bird have special adaptations for feeding?

Repeat the activity. Use:

Crow
Woodpecker
Hummingbird
Blue jay

Materials:

reference books
information cards, Brown Pelican (49-4) and Microbalance (22-1)
bones and feathers of birds
bones of other animals hacksaw

other ways to look at it:

.. Birds are tremendously light for their size. Tiny birds (finches and wrens) weigh less than a pencil. Find out what makes a bird such a feather-weight. Weigh bird bones and feathers. To make a sensitive weighing instrument, read the information card, Microbalance.

.. Carefully saw through a chicken bone. What is inside? How does this compare to the inside of a beef bone?

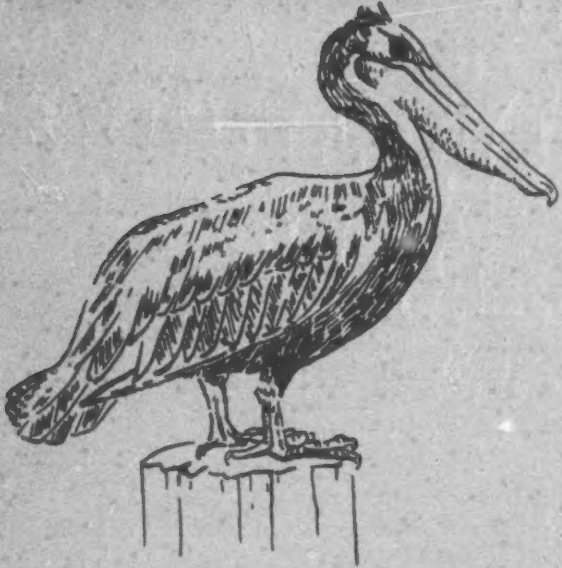
.. Observe several birds that live in one habitat. Sketch their feet and beaks. How are birds adapted for perching, wading? How are the beaks of birds adapted for the type of food the bird eats?

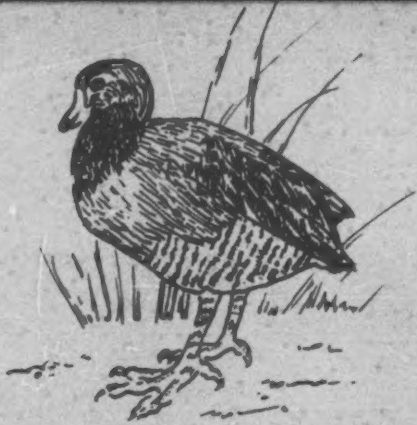
.. Why are some birds in danger of disappearing? Research one endangered bird.

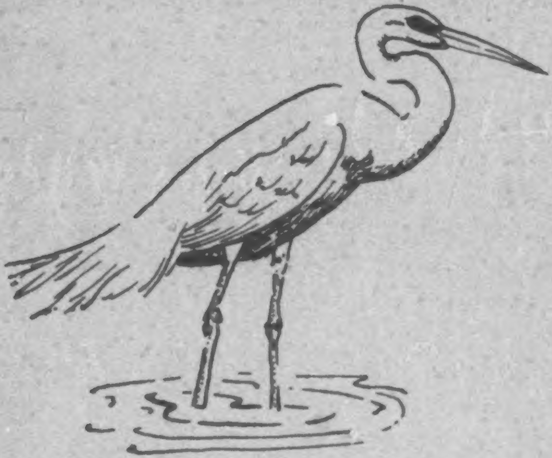
.. Write a poem about birds. Be sure to mention at least one adaptation of that bird.

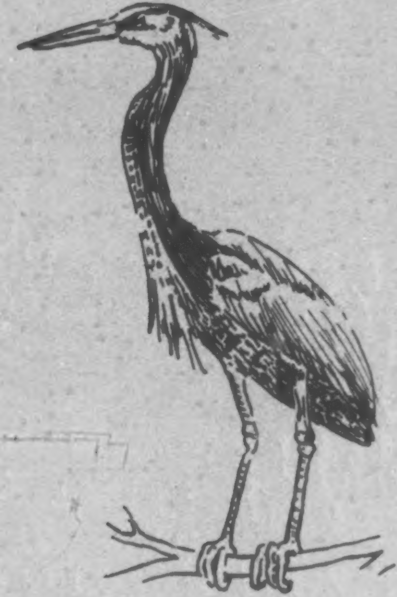
what did you discover?

Present your findings to the class. Show at least three ways one bird is adapted for life in its environment.





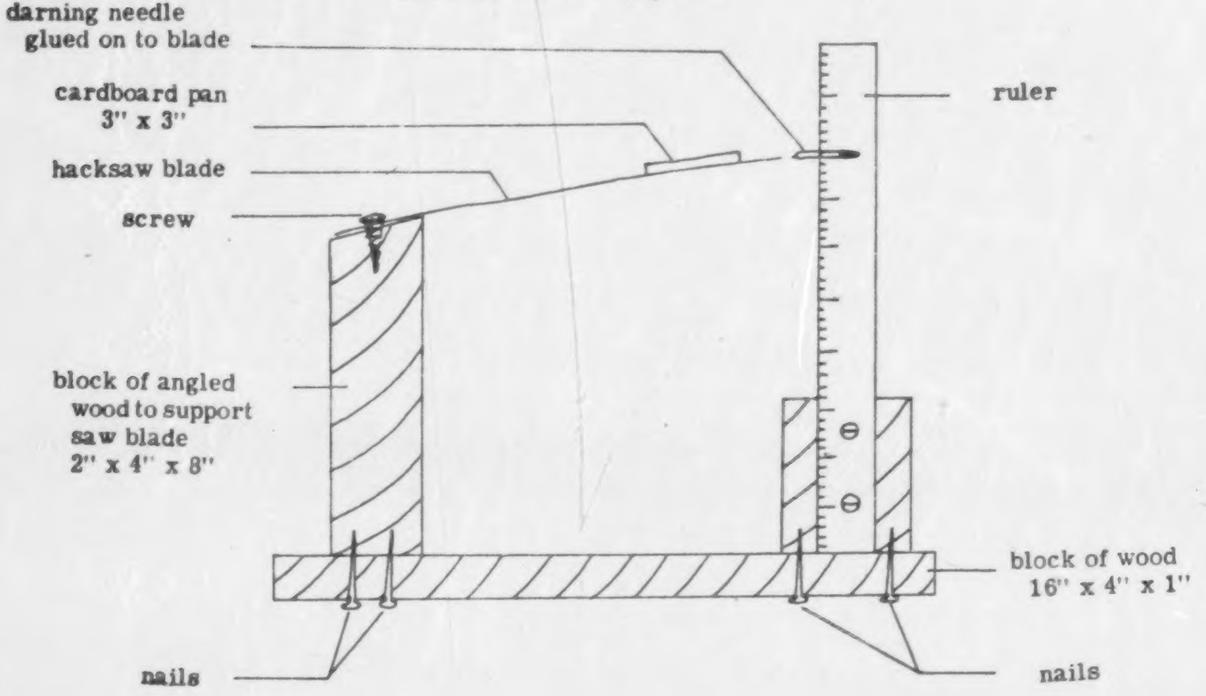




Directions to Construct a Micro-Balance

- Calibrate your scale in grams

1 ounce = 28 grams
a new nickel = 5 grams
a new dime = $2\frac{1}{2}$ grams


darning needle glued on to blade
cardboard pan 3" x 3"
hacksaw blade
screw
block of angled wood to support saw blade 2" x 4" x 8"
nails
ruler
block of wood 16" x 4" x 1"
nails

Materials:
- block of wood 2" x 4" x 8"
- ruler with millimeter marks
- one piece of wood 18" x 4" x 1"
- one piece of wood 1" x 4" x 1"
- string, glue
- cardboard piece 3" x 3"

Resources:

Birds. Mine Publications, Inc. Minneapolis, Minnesota. pp. 69-71.

the problem:

What survival techniques do plant and animal species have to insure new generations?

clues for you:

Carefully read the information card, Six Ways to Success.

Study at least five plants or animals that are native to your area. Report to the class answering the following questions:

How long does this animal live?
How often does it mate?
How many offspring does it have?
How does it protect its young?

Decide which, if any, of the six survival techniques each animal uses.

What happens when the environment changes? Would this animal be able to survive if its environment changed drastically? Can this animal change its survival techniques?

Materials:
information card Six Ways to Success (23-1)
chart or construction paper
reference books

other ways to look at it:

.. Does man use any of these survival techniques? Why has man been so successful in populating the earth? Does man have any weaknesses in his survival techniques?

.. Pick one plant or animal that is considered a pest in your area. What makes this species so difficult to control? Does this species have one of these survival techniques?

.. Do research on animals or plants that have become extinct. Track down the weaknesses in their survival techniques. Read up on endangered species. Determine why new generations are not succeeding in large numbers.

.. Plant seeds have many survival techniques. Study the plants in your area. Make a chart. Show ways seeds are spread and adapted for their special task.

what did you discover?

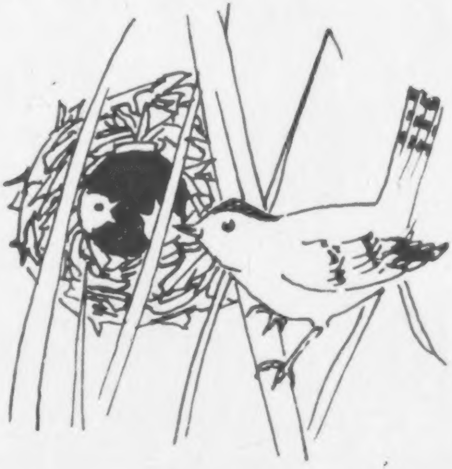
Make a chart. Divide it into six parts, one for each technique. Place the animals and plants you studied in the correct areas. Have your classmates add the animals they researched to the chart.

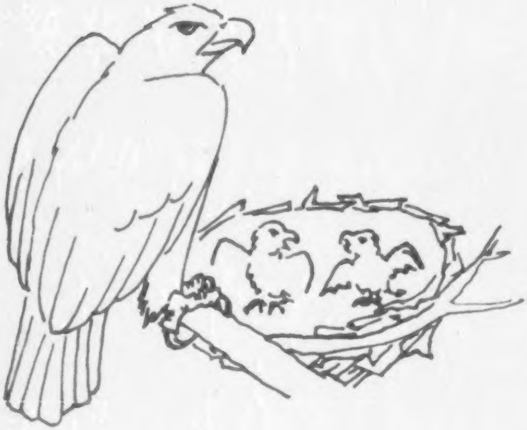
Adaptations for Survival

SIX WAYS TO SUCCESS[1]

1. Reproducing Often

Wrens may raise as many as three broods a year. They breed when they are a year old. If their nests are destroyed, they will build another nest and lay more eggs. They do this as many times as needed to insure their young will survive.



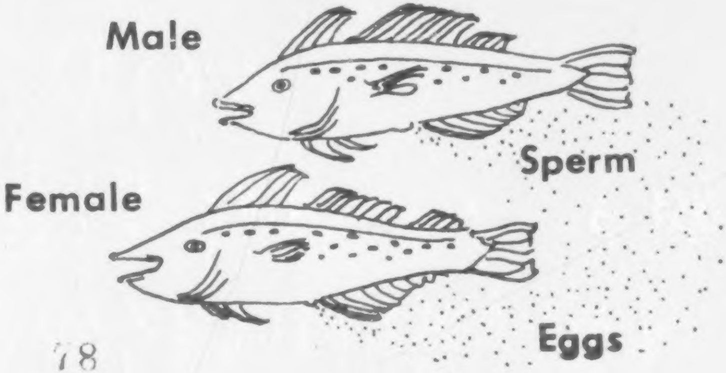


2. Maturing at Different Ages

Eagles live for twenty years or more. They do not breed until they are four or five years old. Each pair of eagles claims a territory. They chase the other eagles from this area. By chasing other eagles away, the pair insure themselves and their young of a food supply. By waiting until they are four years old to mate, the eagle is strong enough to defend its territory and raise its young.

3. Many Sex Cells

When cod mate, the female may release as many as six million eggs. The male releases millions of sperm cells at the same time. The cod do not protect their eggs or young. Although many of them are eaten by other fish, the great numbers of eggs insure that some will survive.



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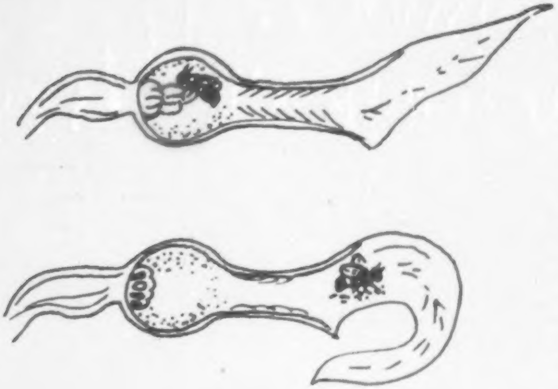
[1] "Six Ways to Success", Nature and Science, March 27, 1967, p. 8.

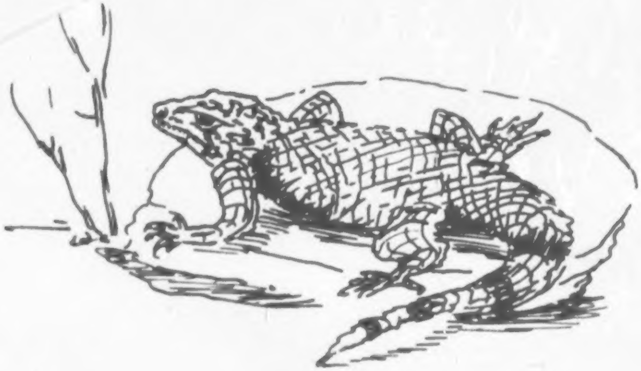


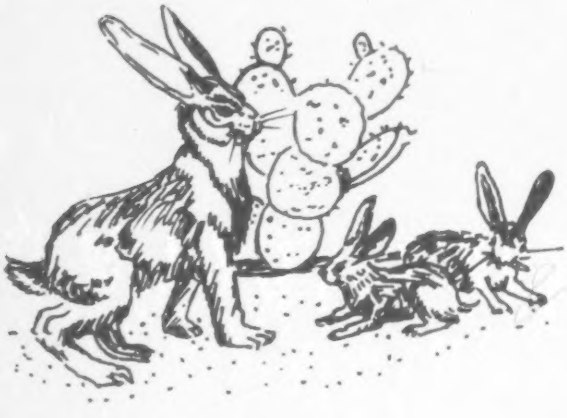
4. Getting Gametes Together

Many kinds of plants have flowers that attract certain insects. When an insect flies from one flower to another of the same kind, it brings the plants gametes (sex cells) together. The Dutchman's Pipe, shown here, traps insects inside until the pollen is ripe. Then the hairs of the flower collapse and the insect crawls out, carrying the pollen with him to the next flower.

5. Protecting the Fertilized Egg

Most female lizards lay eggs and bury them in moist warm places where they hatch. Lizards in cold climates, however, do not lay their eggs. They keep the eggs inside their bodies until they are almost ready to hatch. The female lizard can bask in the sun for warmth.





6. Surviving After Birth

Jack rabbits are able to see, hear, and run soon after birth. They can survive without their mother a few days after birth. Other animals, like the coyote, are helpless for several weeks. They depend on their mother for food and care. They learn to hunt by imitating her. Without parental care, the pups could not survive.

the problem:

What is a population?

clues for you:

Find a low spot in the grass of your school yard. Scoop up some dry, dead grass. Place it in a clean glass gallon jar. Add to this a small sample of pond or ditch water taken near the bottom. Add enough rain water or boiled tap water to bring the level to about 3/4 of the jar. Cover.

Every day, note the appearance of the jar. Examine a drop of the solution under the microscope. Count any animals you see. Continue your observations for three weeks. Once a week, add a pinch of boiled egg yolk.

What happens to the life in the jar after several weeks? Do the populations in the jar change? How did the population in your drop change?

Materials:

grass
hand lens
microscope
slides
boiled water
ditch water
coat hanger
notebook
quart or gallon glass jars
information card, The Environment Cork (24-1)

other ways to look at it:

.. Read the information card, The Environment Cork. In what ways is the environment a cork on populations?

.. Go into an open field (your school yard will do). Toss a hanger into the air. When it lands do a study of the life in the hanger. List the number and type of all living things there. How many different populations did you find?

.. Make a list of all the natural forces that control populations.

.. What happens to a population if there are more deaths than births? More births than deaths?

.. What effect does killing a predator have on other populations?

.. Look at the data you gathered. Make a graph of one population you observed in the jar.

what did you discover?

Make a chart showing how the population you made from the ditch water changed each day.

INFORMATION CARD

The Environment Cork

What does the word population mean? Does it mean only the number of people living in a certain place at a certain time?

The word population can also be used in studying other living things. It can be the number of alligators in a swamp. It can also mean the number of mice in a meadow or the number of trees in a forest.

Every living thing reproduces itself in order to insure the survival of of its species (see information card, Six Keys to Survival). The term biotic potential is used to describe the ability of the species to reproduce.

Not all species have the same biotic potential. Large animals have low biotic potentials. Elephants produce few offspring. So do humans and condors. Smaller animals usually have a higher biotic potential. So do most plants. A pair of field mice can produce 6 baby mice 17 times a year. The young mice soon have their own offspring. In a few months, the original pair can become millions. An oyster can release a million eggs. Insects and frogs lay hundreds of eggs. A tree releases thousands of seeds each year.

Why aren't we up to our necks in mice or frogs? What is it that "bottles up" these populations? What is it that keeps them from covering the earth?

The environment serves as a "cork." It stops the overflow of populations. Many animals are eaten by other animals. Others are killed by disease. Many starve. Some die due to fire, earthquakes, or bad weather. The conditions in the environment determine how many animals and plants will survive.

In early spring, you may see many seedlings sprouting on the forest floor. Only a few survive to become trees. The seedlings compete for sunlight, minerals, and water. The environmental conditions limit the number that will survive. Even as they grow, fire, flood, or bad weather may kill some of the survivors.

There seems to be another "cork" to rapid population growth. This is the behavior of the species itself. When conditions become crowded, some mammal families stop reproducing. Scientists have observed this in a crowded cage of mice. Other species may abandon their young.

For thousands of years, these environmental controls have worked. They have kept populations within environmental limits. Lately, man has learned to control the controllers. He has killed or driven off his predators. He has discovered medicines to help him avoid death and disease. He has learned to increase food production.

These advances have led to a population explosion (see information card, World Population). New problems have arisen. These may prove to be a greater control than nature ever intended. Man is polluting his air and water. Man is beginning to realize that the earth's resources are limited. Populations cannot increase forever.

--Adapted from: Ranger Rick's Nature Magazine, "Populations", by Laurence Pringle, April 1973, pp. 22-28.

For Math Experts Only:

1. On the average, a pair of field mice will produce 5 baby mice 17 times a year. Figure out how many mice the original pair would be directly responsible for in a year.
2. Now, depending on climate, a female field mouse will be ready to breed in three weeks. It also takes about three weeks to produce a litter. Using the accompany chart, comput the theoretical number of mice resulting from a single litter born to our original pair of field mice.

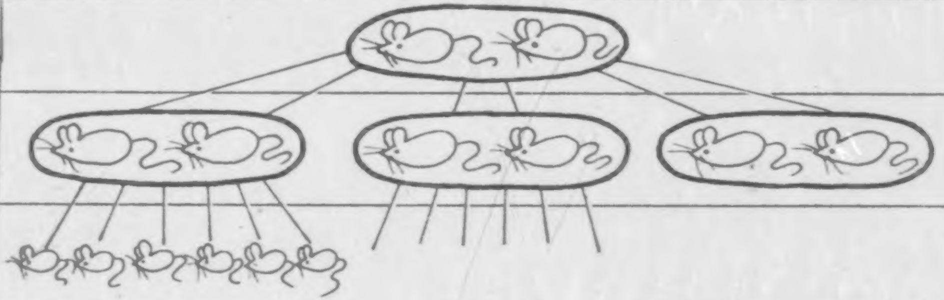
Environmental Cork

VOCABULARY

1. population: number of plants or animals living in a region.
2. species: a group of animal or plants that are alike.
3. biotic potential: the ability of an animal or plant to survive in the environment
4. abandon: leave something alone

POSSIBLE REPRODUCTION PATTERN OF FIELD MICE FROM A SINGLE LITTER

(in a year's time)

number		time
2		start (adults)
6		3 weeks
18		9 weeks
		15 weeks
		21 weeks
		27 weeks

Remember, this total is only one litter's worth. Our original pair may repeat this 17 times in a year, as will each succeeding generation. Why aren't we up to our necks in field mice?

the problem:

What is happening to the population in your area?

clues for you:

The following numbers represent the population of Brevard County.

Brevard County Population*

Year	Number of People
1950	23,500
1960	111,000
1970	230,600
1975 (estimated)	248,000
1980 (estimated)	295,700

*Cape Kennedy Area Chamber of Commerce Figures

What has happened to the population of this area? (If you live in another area, compare your own population figures.) Make a graph of the population in your area over the last 20 years. What is happening to the population? How does this affect the area?

Materials:

graph paper
pencils
ruler
magazines
scissors
poster board
glue

other ways to look at it:

.. Survey the people in your area. Ask how long they have been here. Find out if they intend to stay. Why did they come here? Discuss what you found out about the residents of your community.

.. Study the history of your area. Talk to some people who have lived here for a long time. How has the area changed? What things are responsible for the changes? Report to the class.

.. How does a population change affect the resources of an area? Make a collage showing the resources people in your area need. Does your area have enough resources to support continued growth?

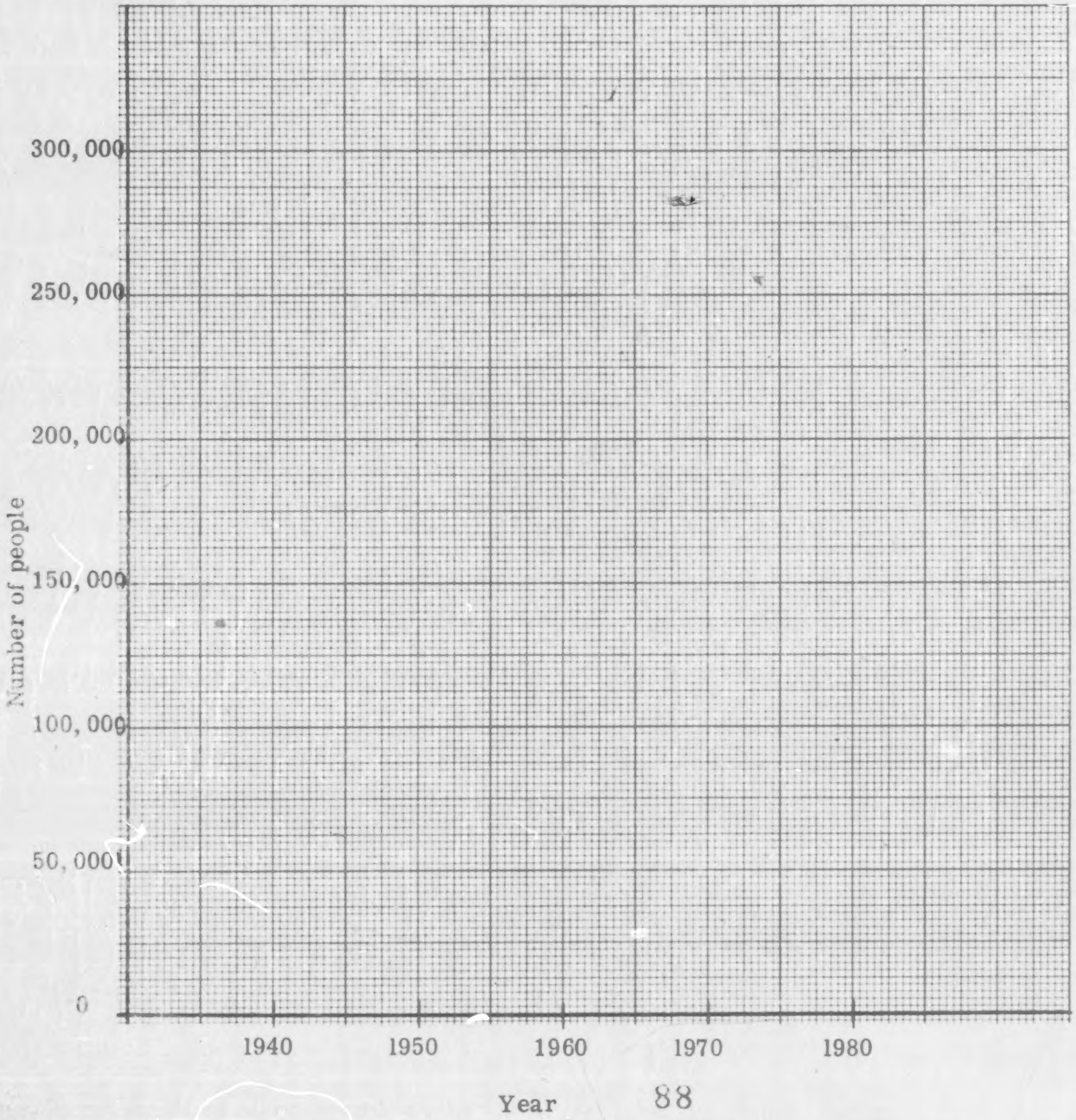
.. Are other living things affected by changes in human population?

.. What is happening to the population of your state? Nation? Find out. Contrast this to the changes in your area.

what did you discover?

Put your graph and the answers to the questions on display in the room. See what information your classmates can add.

POPULATION OF BREVARD COUNTY



the problem:

Will there by standing room only on the world?

clues for you:

On a large table mark off an area 1 yard square, or use your desk top. Get a box of small counting blocks. One block will represent 1 person. Start your population with two "people." Every 30 seconds, add 8 blocks (people) to your world. This represents the people being born every two seconds in real life. Take away 3 blocks (people) every 30 seconds. This represents those people who die in real life every two seconds. What happens to your world after a new minutes? After 10 minutes?

The same thing is happening in the real world. Each second, 4 babies are born and 1.6 people die. Every second we add 2.4 people to the world.

Materials:
data card, Death Rates (26-4)
information cards, World Population
(26-1) and The Environmental Cork
counting blocks, tape (24-1)
materials for collage

other ways to look at it:

.. How many people are added to the world in a minute? In a day? In a year?

.. Read the information card, World Population. List at least three reasons for this increase in world population. What is happening to the world population? How long will it take for the population to double?

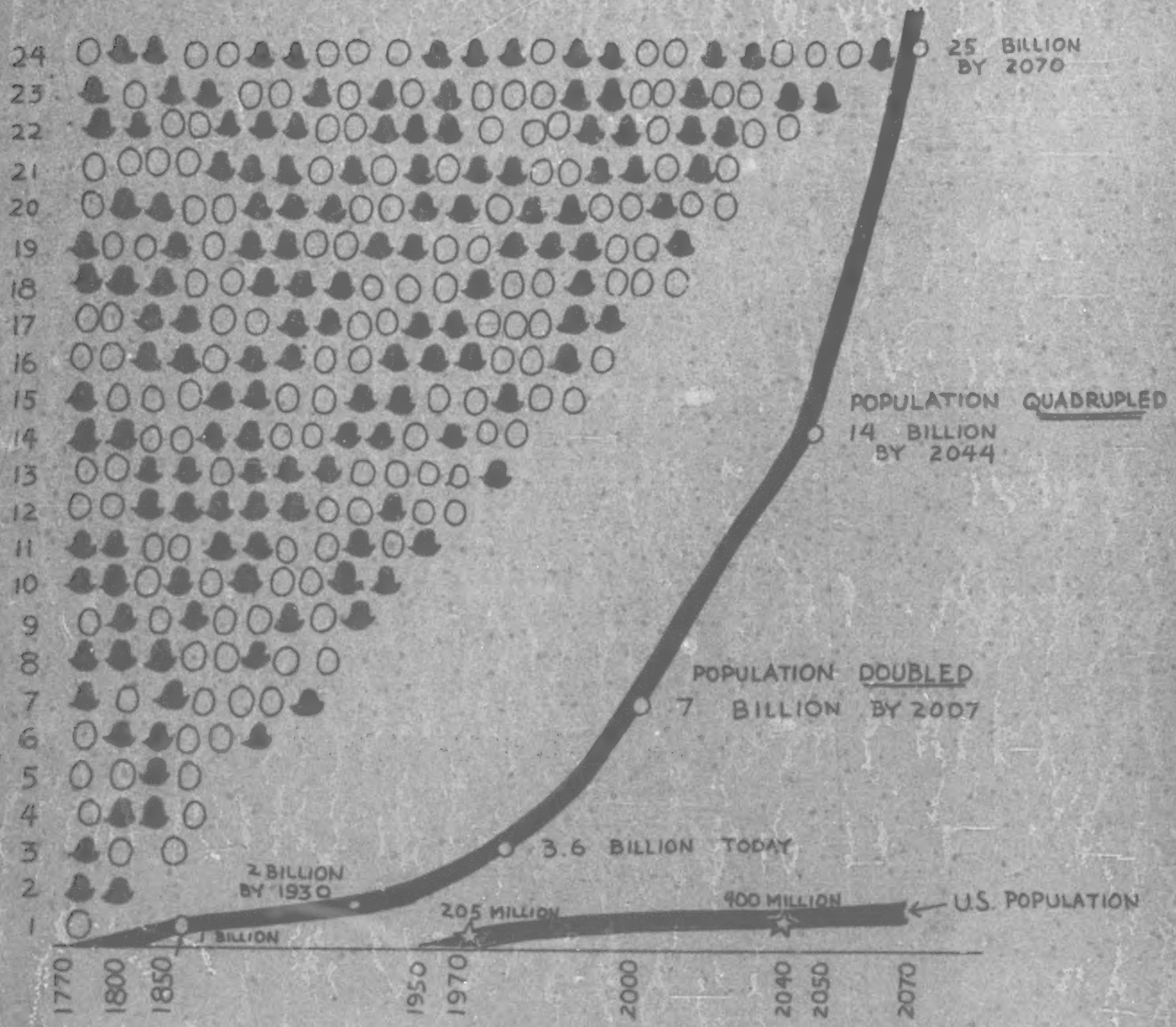
.. Read the information card, The Environmental Cork. How are populations controlled in nature? How has man been able to overcome these natural controls?

.. Take a field trip to a cemetery. Find out if people are living longer now than years ago. Use the data card Death Rates to tabulate your results. Age at death should be calculated. The results should be listed in the time period when death occurred.

.. What is happening to the population of the United States?

what did you discover?

Make a collage. Show what you think the world will be like in 35 years.



○ OR ● -1 BILLION PEOPLE

WORLD POPULATION GROWTH

Source: 1971 EQ Index, National Wildlife Federation.

World Population

Suppose this page were completely full of dots the size of those along the top and the margin. How many dots would there be on the page? If you fill in the rest of the dots there will be 4900 dots. Add 100 more and you will have 5000. How many pages of dots would it take to show 1 billion? It would take 200,000 pages. The average size phone book has about 400 pages. This means it would take 500 phone books filled with dots on each side of the page to represent 1 billion. That's a lot of dots.

The world population is now at 3.8 billion people. That means 2000 phone books filled with dots to represent the world population. Figure out how high the stack would be. The world population in 35 years will be 7 billion. That's 3500 phone books. In 70 more years the population will have jumped to 14 billion unless something happens to slow down the growth rate. What is causing this jump in population?

One hundred thousand years ago, the population was small. People lived in caves and hunted for all their food. When someone wanted something to eat, he had to go out and look for it. If he did not find any food then he went hungry. In winter the cave was the only protection people had. Many died and few lived for long.

Man survived those trying times. He soon began cooperating in the search for food. Large groups would hunt at the same time. It became easier to get food. Some people began to grow food in the area of their own "houses." Animals could be caught ahead of time and stored alive in corrals. Man began living in "cities." Since they didn't have to spend so much time hunting, the could make clothes from skins. They made tools to help them hunt better. Man was beginning to control his environment. Many children still died young, but the death rate was decreasing.

One of the factors controlling the rate of population growth rate was disease. Man still had not learned how to control germs. Many diseases continued to wipe out large numbers of people. Some people migrated to other parts of the world. The population became more spread out. This helped to increase the rate of growth since the diseases were not carried as easily across the oceans. As newer methods of disease control were discovered, the death rate among the population declined. More people lived to produce more children.

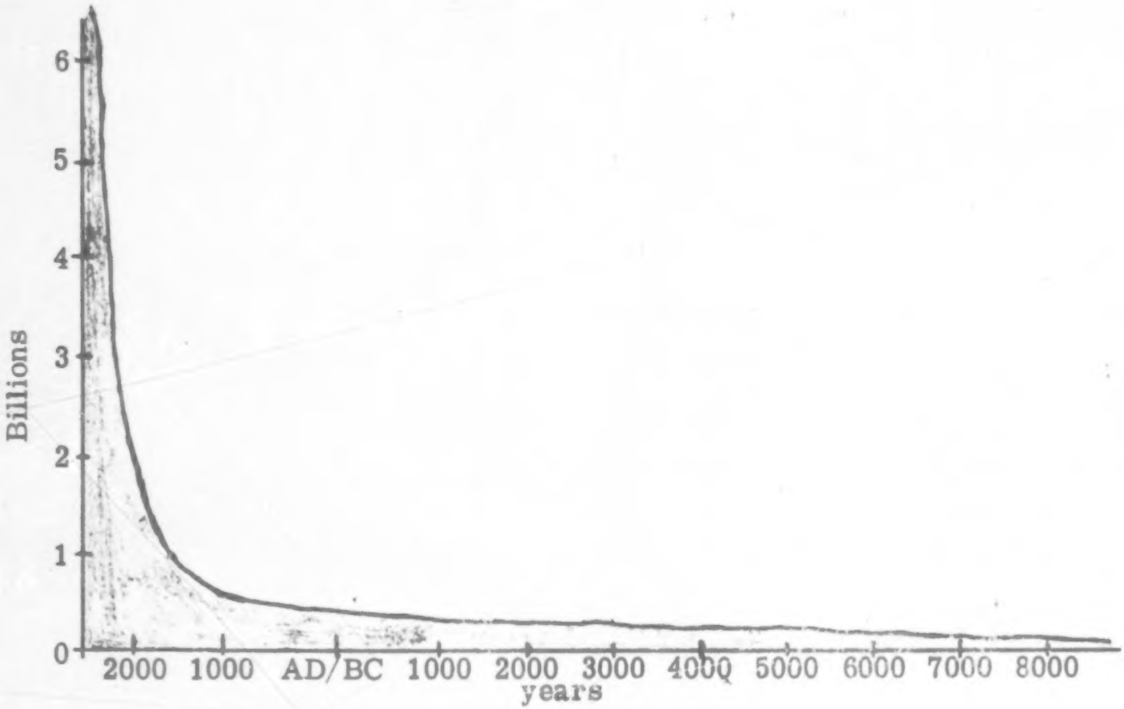
Another factor controlling population growth is war. War destroys people. This reduces the population growth rate a little but not as much as the natural wars with the forces of nature. Famine wipes out entire population areas. Famines can be caused by drought, or by insect populations eating the food crops. Irrigation has provided areas for crops that were not available in earlier times. As food becomes more plentiful, the population growth rate increases.

Modern technology has made life easier for people. There is more time to relax and rest. People do not have to spend as much time looking for food. Diseases, famines, and natural disasters that wiped out entire populations have been brought under control. The result is an increasing world population that threatens to make the earth one large people-standing-place. In the year 2500, if the population continues to grow at the present rate, there will be one person per square foot of earth. The earth will truly have "No Vacancy."

VOCABULARY

1. famine: a period of time when food crops fail
2. drought: a long period of dryness
3. irrigation: to supply with water for agriculture
4. technology: a method of making things like machines

World Population



Country	Birth rate	Death rate	per 1000 population
Mexico	43	10	
Brazil	38	10	
United States	15. 6	9. 4	
U. S. S. R.	17. 8	8. 2	
India	42	17	
China	30	13	
WORLD	33	13	

Data Card

Death Rates

Age at death	1821-1870	1871-1920	1921-1970
0-5			
6-10			
11-20			
21-30			
31-40			
41-50			
51-60			
61-70			
71-80			
81-90			
91+			

the problem:

An increasing world population causes what type of problems?

clues for you:

Where does the world's population live? Arrange your desks as follows:

- 6 desks (Africa)
- 6 desks (Europe including Russia)
- 5 desks (North America)
- 4 desks (Latin America)
- 5 desks (Asia)

Each desk represents 1/25 of the world's land surface.

Make your world more realistic. Add the following people. (Each person represents 1/25 of the world's population.) Two students for North America, 14 for Asia, 2 for Africa, 5 for Europe (including Russia), 2 for Latin America.

Where would you rather live? Where would you have the most room? What do you think will happen in 35 years? 70 years?

Materials:

information card, Problems with Populations (27-1)
candy
resource books

other ways to look at it:

.. What will all these people eat? Take 25 pieces of candy and divide them as follows: one each to Latin America and Africa, eight each to Asia and Europe, and seven for North America. This represents the food distribution and the amount each continent produces. Suppose the population doubles, does the food supply double? The population will double every 35 years. What will happen to the food supply in this time?

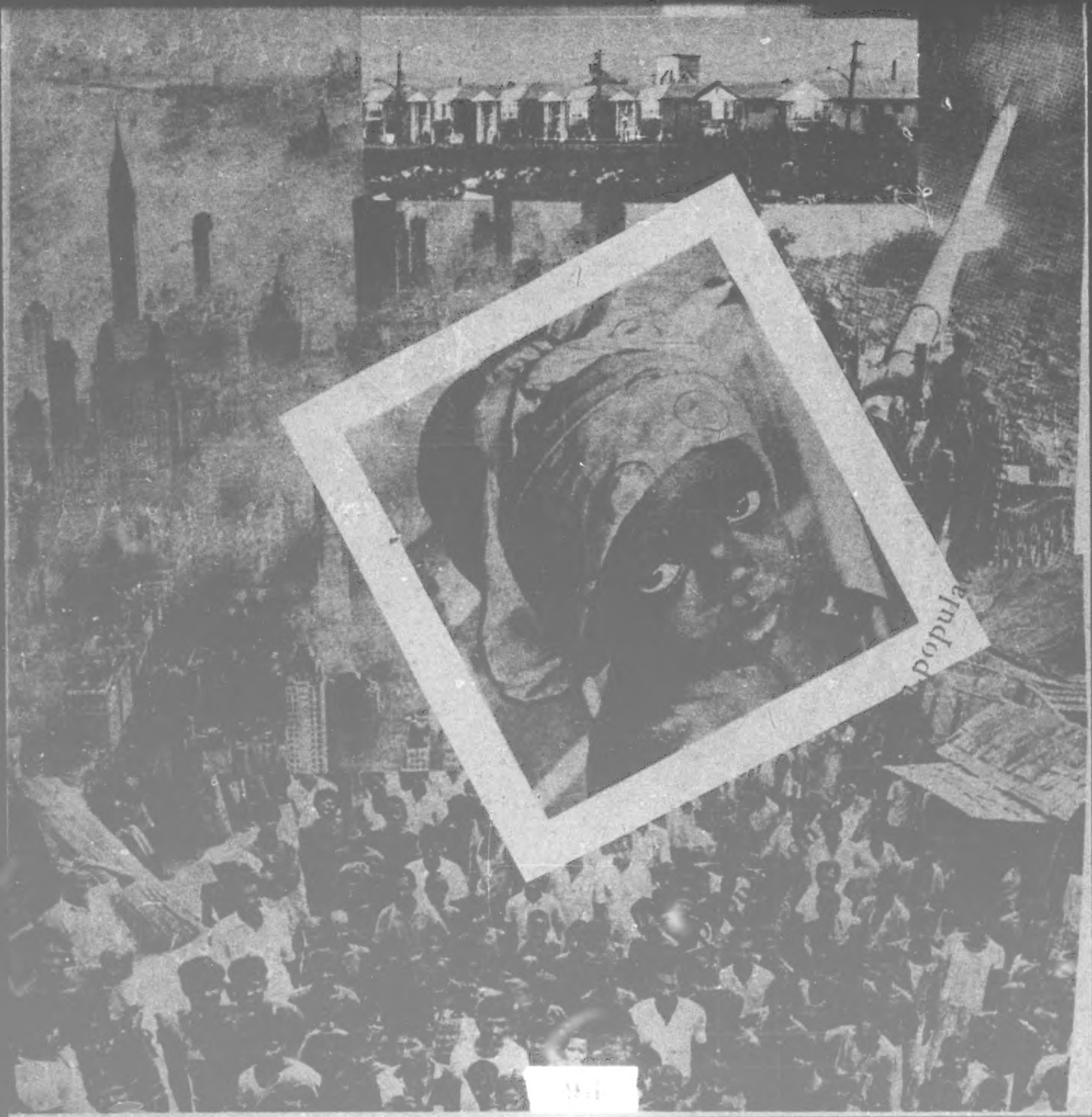
.. Read the information card, Problems with Population. What are some of the problems a population growth produces? Make a list of the resources people use.

.. Can modern technology keep up with the population growth? Suggest inventions that will allow the earth to support more people.

.. What will happen to waste disposal in future years if the population increases?

what did you discover?

Make a display. Show at least three problems an increasing world population brings.


popula

INFORMATION CARD

Problems With Populations

Study the cover of the activity card on world population. As you can see, the population is growing at an alarming rate. More people need more land, more cars and more services. They pollute the air, water and the land. They use valuable resources.

Look at the population of the United States. In 1973, the birth rate fell to 2.03 children per family. It it were not for immigration, the U.S. population would not increase. So we don't have anything to worry about, right?

WRONG!

By the time he is 70 years old, the average American will have used 26 million gallons of water and 21,000 gallons of gasoline. He will have eaten 10,000 pounds of meat. He will have consumed 14,000 quarts of milk, and used $6,000 worth of clothing.

Every year, Americans throw away 100 million tires and 20 million tons of paper. They also discard 28 billion bottles and 48 billion cans. No wonder we spend $2.8 billion on garbage collection!

Americans make up only 5% of the earth's population. They consume 40% of the resources each year. They also account for 30% of the world's pollution.

More people will use up more land and minerals. That's why environmentalists have concluded that America must stablize her population. Some go so far as to say it should be reduced. Dr. Ernest Hauser is an internationally known population expert. He predicts that if all people had a standard of living equal to Europeans the earth could support only 1.5 billion people--half as many as it has now.

--1971 EQ Index. Washington National
Wildlife Federation, 1970.

Questions for Thought

1. Have you done the activity cards on population?
2. What problems would result from an increased world population?
3. What can be done to help solve this crisis?
4. Why do Americans consume such a large percentage of the earth's resources?
5. Why could the earth support fewer people if the standard of living increased?
6. (For math experts only.) Figure out how much of the following would be used by a city of 200,000 people over a 70-year period:
    a. water
    b. gas
    c. meat
    d. milk
    e. clothing (value)

VOCABULARY

1. consume: use up
2. environmentalists: people who study the environment, and are interested in protecting it
3. stabilize: keep at one level, or in one condition
4. reduced: made less
5. crisis: very serious problem that must be solved immediately

the problem:

How much land do you use ?

clues for you:

Each individual in the United States needs the following amounts of land:

1 acre for producing grain
4½ acres for grazing animals
½ acre for producing fruits and vegetables

How many acres of land are used to feed the members of your family ? To feed the members of your class ? The people in your state ? The people in the United States ?

How many acres of land would it require per person if you ate no meat ? Can a person live without meat ?

What other ways could the amount of land per person be reduced ? Suggest at least two ways.

Materials:
encyclopedia
World Almanac
Coca-Cola game, Make Your Own World

other ways to look at it:

.. Land use in the continental U. S. is as follows:

544 million acres - grassland pastures
373 million acres - forest pastures
355 million acres - cropland
398 million acres - ungrazed forests
125 million acres - tundra, swamps, mountains, deserts
61 million acres - wildlife refuges, parks
54 million acres - urban areas and transportation routes

Figure it out: How much unused land is there in the U. S. ?

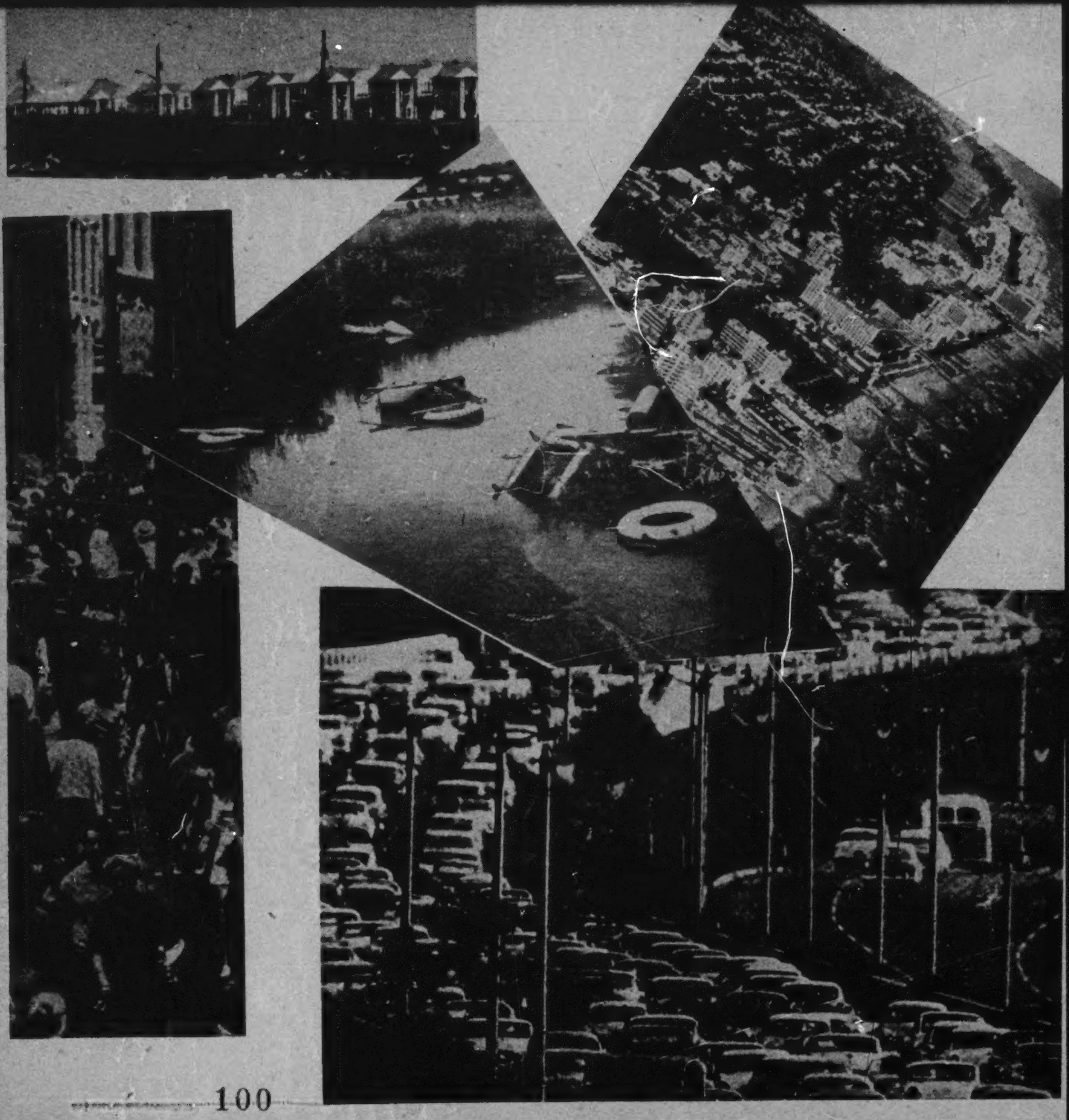
.. Play the Coca-Cola game, Make Your Own World. Decide how the land should be used.

.. What effect will population growth have on the above figures ?

.. If more land is needed for urban areas and transportation, where should it come from ?

what did you discover?

Design a model community. Show how each piece of land is used. Be sure to include land for raising food, recreation, sewage treatment, and transportation.



e problem:

Are there special areas of you school or schoolyard where litter is found?

lues for you:

Take your notebook and pencil, and
r your classroom. List the places
ere you see litter. Note what kind
litter it is.
Tour your schoolyard. List the
ation, amount and types of litter
u find.
Draw a map of your classroom and
ur schoolyard. If you need help,
ad the information card, Making A
p.
Make up a system of symbols for
e types of litter you found. Using
mbols on the map, show where
ch type of litter was found.

paper *	cans□
plastic○	others -
glass	

llect all the litter you find.

aterials:
formation card, Making A Map (29-1)

ncil	watch
per	tapemeasure
tebook	bags or trashcans

other ways to look at it:

.. Did you find a place where no litter was found? Why is there no litter?

.. Start an anti-litter campaign. How can you educate your friends at school without causing more litter or solid waste?

.. Try creating a spot announcement about preventing litter. See if you can give it to other classes.

.. Make a survey of your community. Are there places where litter collects? See what you can do about it.

.. Measure the volume of the litter you found. If this much builds up in one day, how much will there be in a week? Month? Year? (HINT: Volume = Length x Width x Height)

.. Use some of the litter you found to make a garbage' (garbage collage).

.. How much of the litter you found will decay?

hat did you discover?

Discuss the problem of litter on the school grounds. As a class, decide on one project to reduce the amount of litter. Keep records. Decide if your project was effective.

JUNK
TRASH
LITTER

INFORMATION CARD

Making a Map

Making a map is really easy. All you need is a watch, a tape measure or yardstick, pencil and paper, and yourself. Here's what you do--

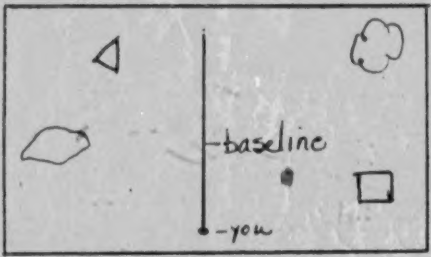
--First, stand in the area you want to map.

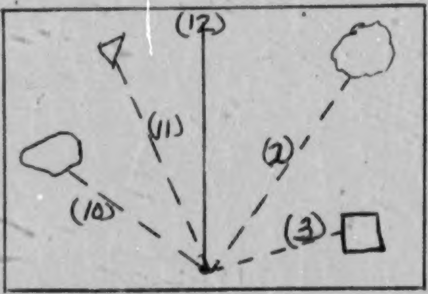
--Next, measure off a base line. Measure your pace and then pace off the base line. The base line should go across most of the area you are going to map.

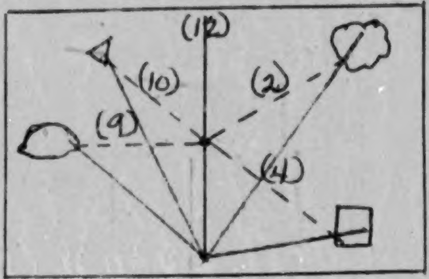
--Third, stand at one end of the base line. Hold your watch so the 12 is aimed straight along the base line. Proceed to locate the objects on your map using the face of the watch.

--Now, go to the middle of the base line. Locate the same objects again using the face of the watch as before. Be sure you are facing the same way. Each place the two lines intersect is the location of an object.

--Now you are ready to put your map on paper. First you must decide on a scale. The scale allows you to fit your map to a piece of paper.







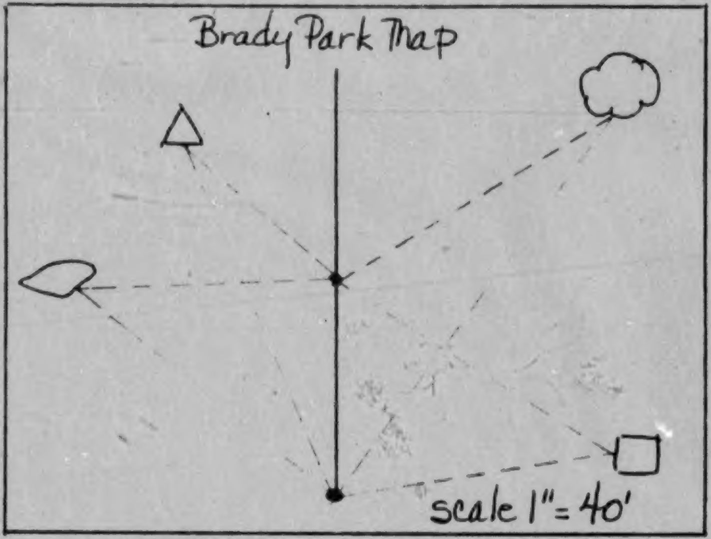
The size of the area you map will determine your scale. A piece of paper 8" wide will map the following sizes:

a scale of 1" = 100' will map a space 800' wide

a scale of 1" = 40' will map a space 320' wide

a scale of 1" = 20' will map a space 160' wide

Your finished map should look like this:



Note: If you have trouble holding your watch steady, try this. Stick a thick yard stick or board into the ground. Put a lump of clay on the end of the stick. Place the watch on the clay with the 12 pointing along the base line. Sight across the watch to the object.

the problem:

The U. S. spends over $4½ billion each year on solid waste. How do you contribute to this problem?

clues for you:

The problem of solid waste starts at home. Keep a record of everything your family buys and throws away for two days. Get the rest of your family to help. Post lists by all trash baskets and garbage cans.

Study your lists. Decide what you could have reused or recycled. Could you have bought containers that will decay rather than metal or glass?

Did you really need the things you bought? How long can you use them?

Read the information card, The Things We Throw Away. What problems is garbage causing? How is the country handling the problem? What plans are being made for the future?

Write a short report for the class. Answer these questions.

Materials:
information cards, The Things We Throw Away (30-1), Recycling (30-3)
garbage
shovel

other ways to look at it:

.. Try composting your garbage. Use the compost for fertilizer.

.. Locate a grocery that does not prepackage produce. Compare their price for produce with a store that does prepackage it. Are you paying for wrapping you throw away?

.. Compare the price per ounce of soda pop in a can to that in a returnable bottle. Which costs more? Compare other items in returnable and nonreturnable containers. How do nonreturnable containers hurt the environment?

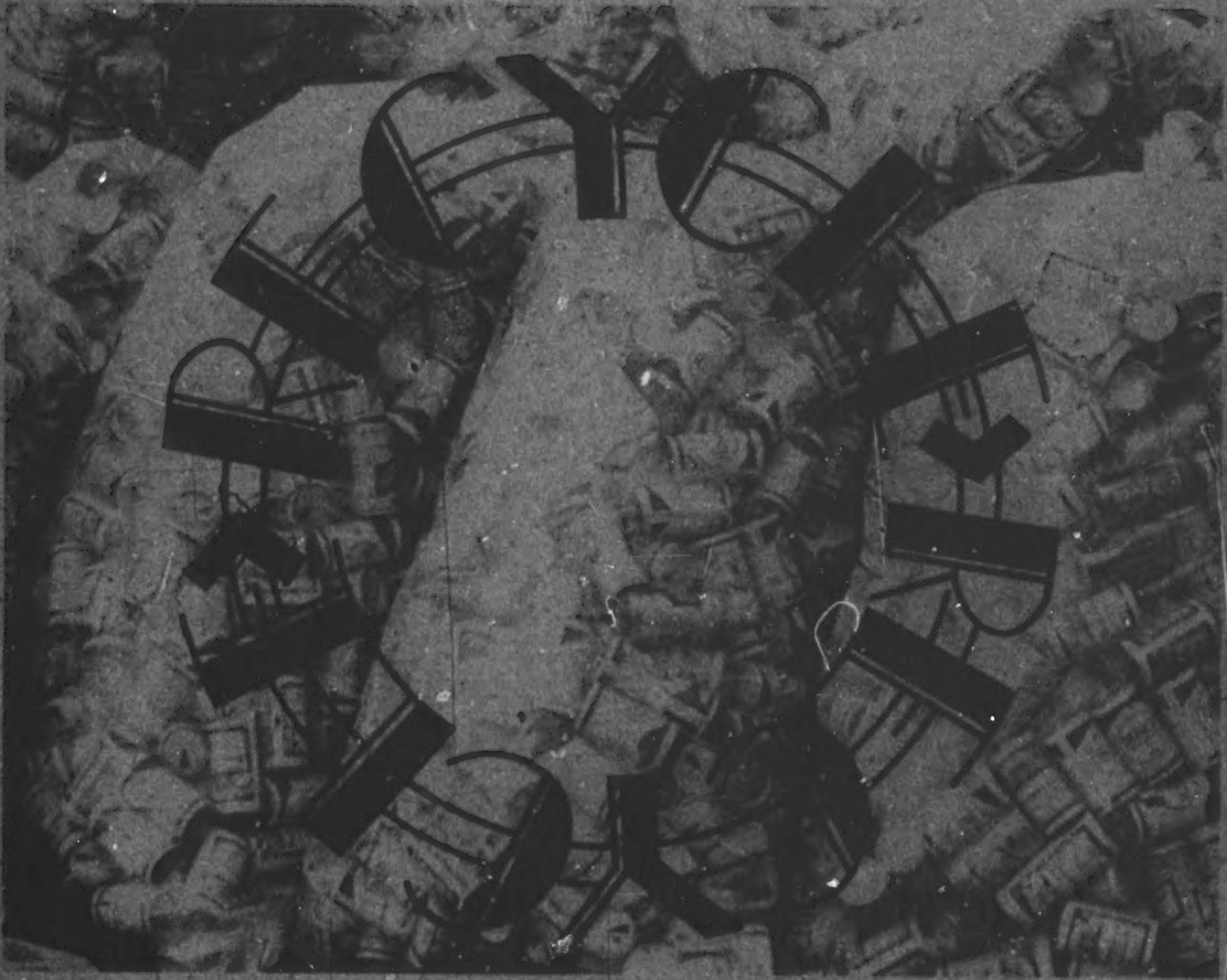
.. Read the card, Recycling. How do we save two ways when we recycle?

.. Have your class save all their newspaper for a month. Take the paper to the recycling center. How many pounds of newspaper did the families of your class use in a month? Use the money to plant a tree.

.. How is garbage in your area disposed of? Does it hurt the environment?

what did you discover?

Make a bulletin board showing your record of purchases and throw-aways. Include some examples of which purchases could have been avoided and materials reused. Display some original ideas of how throw-aways can be reused.



INFORMATION CARD

The Things We Throw Away . . . . .

Man has always had a problem with trash. Even the earliest cavemen had some things to throw away. But things were simple then. Most of what early man threw away was animal or vegetable matter that quickly returned to the earth through decay.

Things started off simply enough. But today, solid waste has become an enormous problem! In the U. S. alone, we produce 4.3 billion tons of solid waste each year. This is 6 pounds per day for each person in the United States. By 1980, it is expected to be 8 pounds per person per day. Much of this garbage will not decay. Glass, metal, and plastic stay in the environment for years.

Where do we put all this trash? Most of it (95%) ends up in open dumps, including the ocean. Open dumps are a breeding place for carriers of many diseases. Rain washes through the dump and pollutes ground water.

The next most popular method of disposal is the sanitary landfill. A sanitary landfill is where garbage is dumped, leveled off, and covered with soil every night. More garbage and soil are added until the site is filled in. After 10 or 20 years of settling, the land can be used for parks, playgrounds, golf courses, or airports. A sanitary landfill is more expensive to have than an open dump, but the advantages are obvious.

About 15 million tons of garbage is disposed of in incinerators each year. Incinerators burn the garbage. Many of the older incinerators add to our problems with air pollution, and must be changed.

Much of America's garbage will not be collected. Sixty million tons of garbage are left to litter our countryside each year.

What is the outlook for the future? Each year America's solid waste problem gets bigger. In 1970 congress passed the Resource Recovery Act of 1970. It is designed to encourage us to find new ways to manage solid waste. Scientists are exploring ways to recycle much of solid waste while the rest is burned to produce energy. Ways are also being explored to encourage industry to recycle materials.

Source: My World, Your World. Washington: U.S. Gov't Printing Office, 1972.

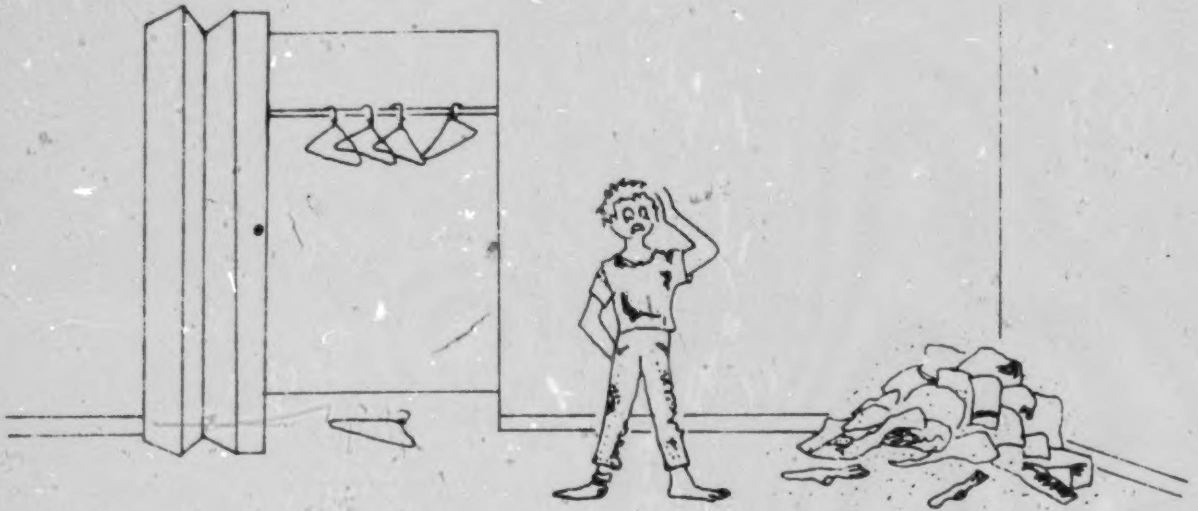
VOCABULARY

1. enormous: very large
2. sanitary landfill: a place to dump garbage (usually in a swampy area) dirt is then used to cover the garbage.
3. incinerators: used to burn things

Recycling

What would happen if

-- you never wore your clothes twice?
-- every time your clothes got dirty, you threw them in a pile and never washed them?



You would soon run out of clean clothes--and would have a big pile of used clothes!

We know we have to use our clothes more than once, but there are many things we don't reuse. We don't reuse newspapers, paper cups, plastic forks, glass containers or aluminum cans. When we are finished with them, we just discard them. Someday we may have nothing left but a big pile of garbage! Each time we use things only once, we are adding to the problem.

Most of the things we use every day like aluminum, steel and paper are made from raw materials called natural resources. Some of these natural resources are called non-renewable, because they cannot be replaced. Others can be replaced if we do not use the materials faster than nature can replace them.

To recycle something means to use it again. There are several reasons why recycling is good:

1) It conserves our valuable natural resources.
2) It makes less garbage to dispose of, and
3) It saves money.

Here are some ways in which you and your family can help save natural resources by recycling:

1) Don't buy non-returnable bags and containers. Buy bottles that you return for a deposit rather than bottles that you just throw away (non-deposit bottles). Tell your mother to buy fruits and vegatables that have not been wrapped in plastic. You will have to buy some bags, but try to reuse them.

2) Don't buy plastic containers. Plastic containers cannot be recycled. They do not rot. They just add to the garbage pile. Many things come in glass, metal or paper containers that can be recycled. If you must buy something in a plastic container, try to find a use for the empty container instead of just throwing it away.

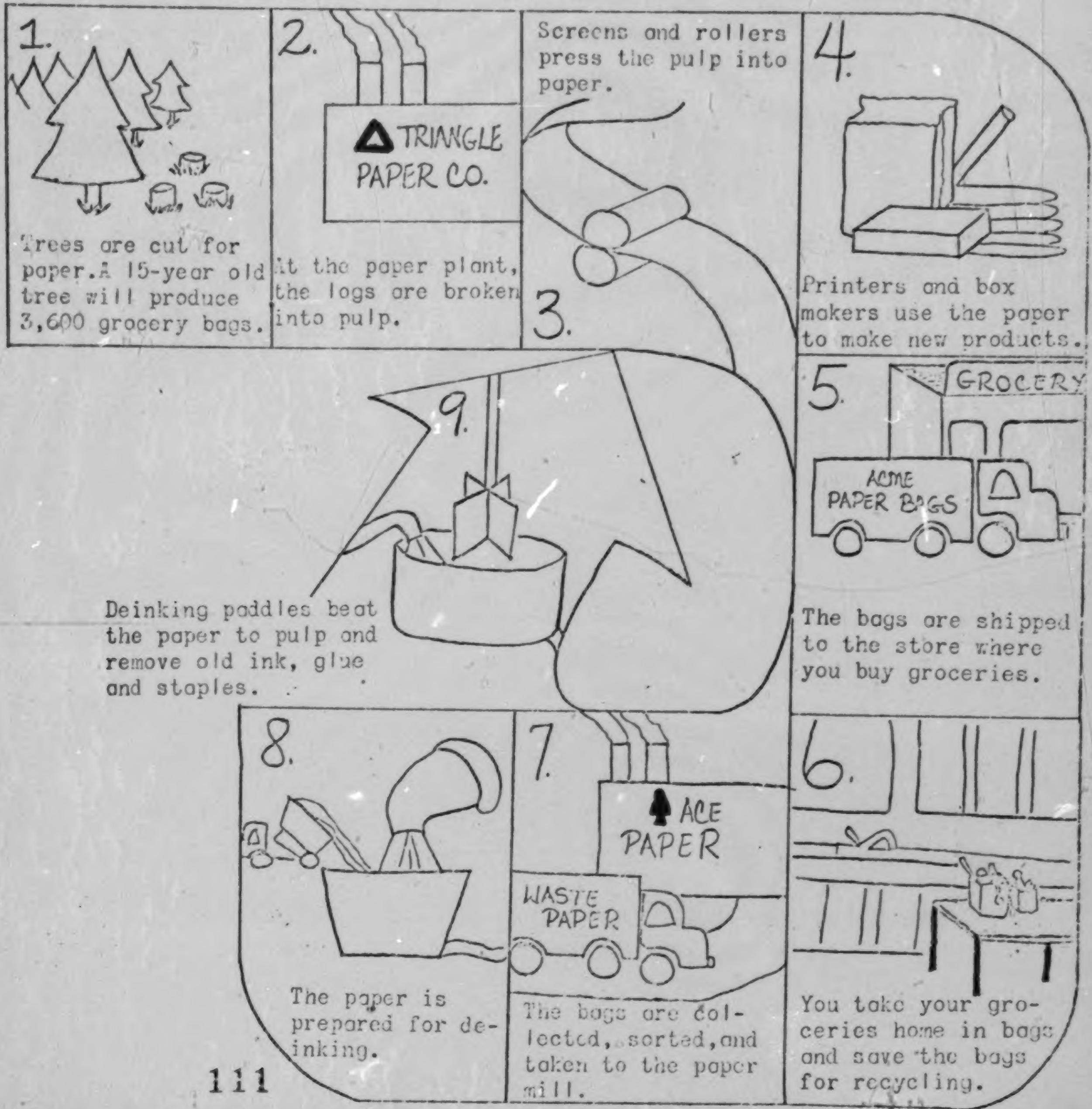
3) Try to use fewer paper products. Paper plates, napkins, paper towels, tissues, newspapers, writing paper and magazines all add to the problem of garbage. Try to be careful in your use of paper products and then recycle the used paper.

4) Recycle all materials that you can. Aluminum, glass and paper can all be recycled. Recycling saves natural resources, reduces solid waste, and makes some money for you, too.

5) Find uses for materials that can't be recycled. Plastic materials cannot be recycled, but they are hard to dispose of. Try to find ways to use these materials. You can use cut-off containers for storing toys and crayons. Foam from meat trays and cups can be cut to make mobiles. Plastic forks and spoons can be reused.

6) Make a compost pile with some of your garbage. All the organic materials in your garbage (except meat) can be recycled by making them into fertilizer for your lawn or garden.

RECYCLING PAPER SAVES TREES


1.
2.
TRIANGLE PAPER CO.
3.
4.
5.
GROCERY
ACME PAPER BAGS
6.
7.
ACE PAPER
WASTE PAPER
8.
9.

1. Trees are cut for paper. A 15-year old tree will produce 3,600 grocery bags.

2. At the paper plant, the logs are broken into pulp.

3. Screens and rollers press the pulp into paper.

4. Printers and box makers use the paper to make new products.

5. The bags are shipped to the store where you buy groceries.

6. You take your groceries home in bags and save the bags for recycling.

7. The bags are collected, sorted, and taken to the paper mill.

8. The paper is prepared for deinking.

9. Deinking paddles beat the paper to pulp and remove old ink, glue and staples.

the problem:

Air is a mixture of certain elements and compounds, mainly nitrogen, oxygen, carbon dioxide and water vapor.

Are there certain situations which occur that will cause a change in the proportion of any of these?

clues for you:

Take some water and mix in a little dirt. Put the dirty water into a small, shallow dish. Observe the dish for several days. Where does the water go? Record the amount of water you used and the length of time it took to disappear. Did you increase or decrease the amount of water vapor in the air?

Take a glass and place it in a shallow bowl. Fill the glass with ice and keep it filled. What happens on the side of the glass? Where does the water come from? How much water do you get? Record again the time and the amount of water formed. Did you increase or decrease the amount of water vapor in the air?

Materials:

information card, Measuring the Microclimate of a Habitat (54-6)

water	glass
dirt	ice cubes
shallow dish	

other ways to look at it:

.. Recycle means to use over. The water cycle is nature's way of recycling water. Show how water that falls as rain can be used and then return again as rain.

.. Do some reading about water vapor or moisture. List some of the effects on the environment of increased moisture in the air. Do the same for decreased moisture in the air.

.. The amount of moisture in the air is called humidity. Read the data card on Measuring the Microclimate of a Habitat. Find out how humidity is measured.

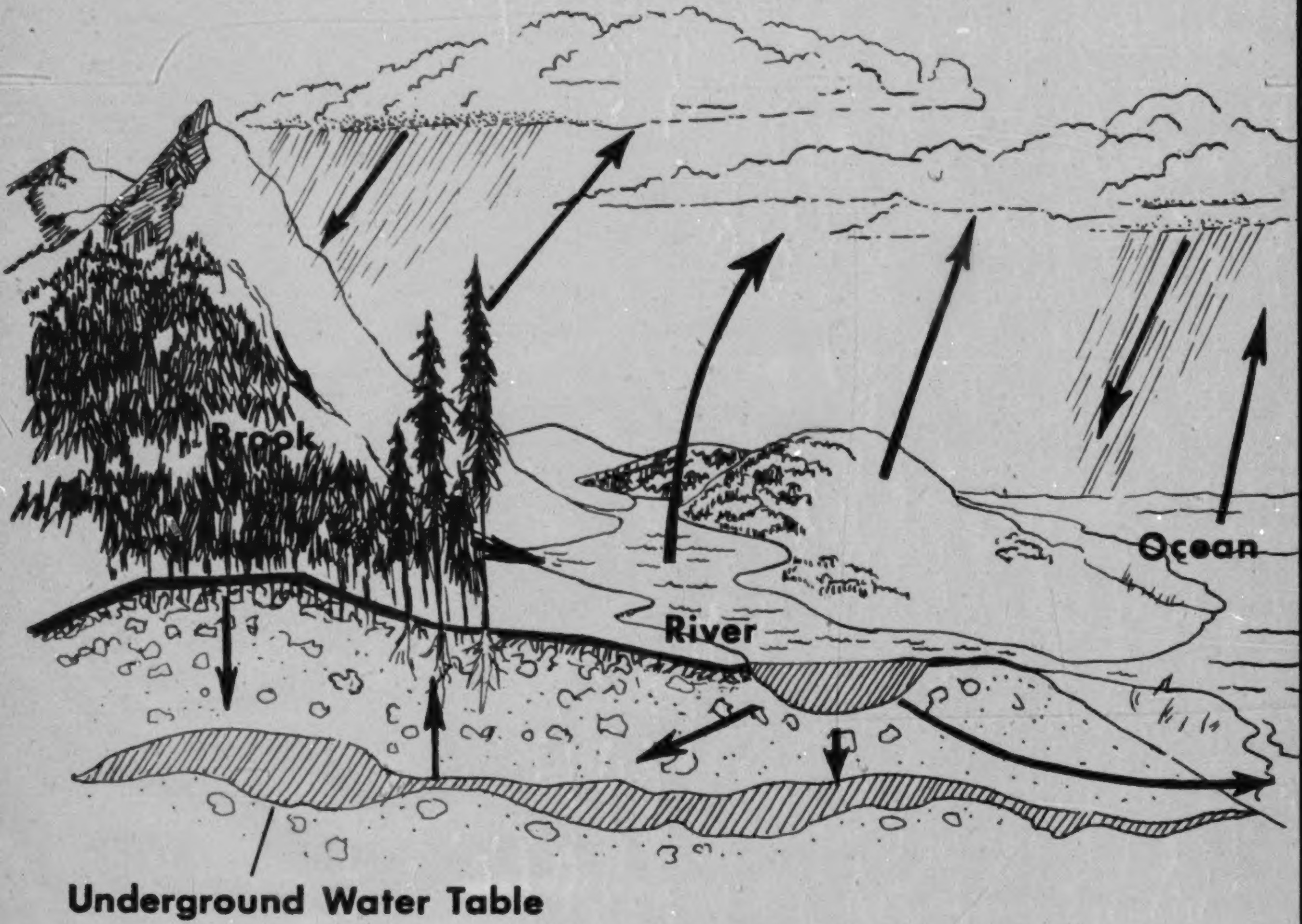
.. Keep a record of the relative humidity in your area for several days. What does the relative humidity tell you about water vapor?

.. Go outside early in the morning or late at night. Look for examples of condensation.

what did you discover?

Draw the water cycle. Describe what conditions would be necessary to cause it to "rain" in a large glass bowl.

WATER CYCLE


Brook
River
Ocean
Underground Water Table

the problem:

How can impurities in water be removed?

clues for you:

Make a filter. Start with a gallon can. Punch holes in the bottom. Add a layer of gravel several inches thick. Cover this with a thick layer of sand. The can should be at least half full.

Make a solution of dirty water. Catch the water that comes out. How has it changed? Repeat this experiment. This time use a solution of salty water. Taste the water when it comes out. Has it changed? How can you get rid of the salt in the water? Try it.

How does nature remove these impurities from water? What are some of the disadvantages of having nature do this job?

Materials:

information card, Waste Water Treatment (37-4)

balance
salt
water

dirt
sand
tin can

other ways to look at it:

.. Repeat the experiment to remove salt from water. This time, weigh the salt before you start. When you finish, weigh the amount of salt you recovered. Did you get all of the salt back?

.. Read the card, Waste Water Treatment. How are the filtering and settling processes used in the treatment of water? What other methods are used to purify water?

.. Will filtering remove disease germs from water? How can they be removed?

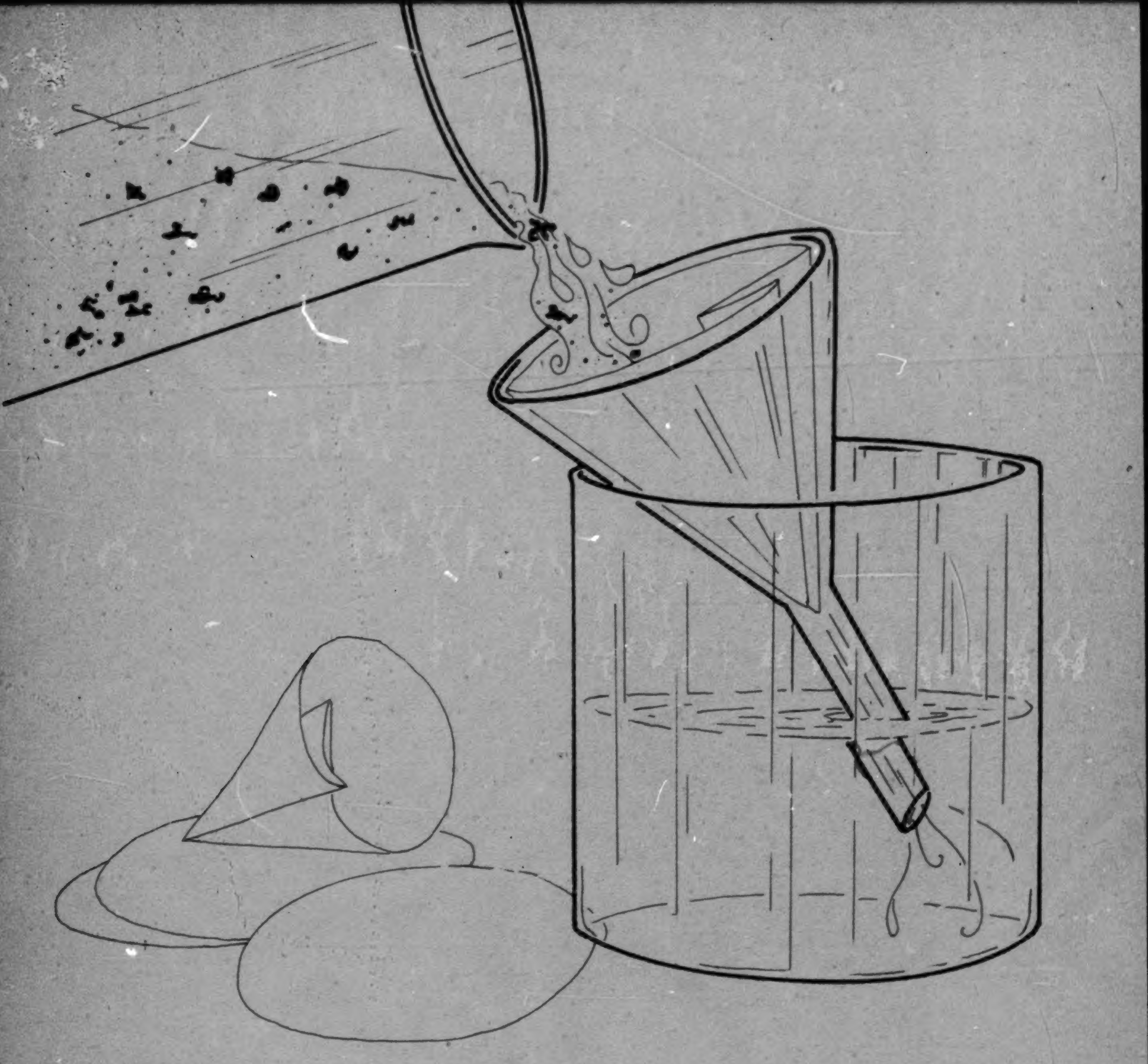
.. Locate a drawing of the water cycle. Study it. Make your own drawing of a water cycle. Show how the steps in the water cycle purify water.

.. What happens when man uses water faster then it can be purified and replaced by nature?

.. Make a list of natural materials that might pollute water. Show how they can be removed.

what did you discover?

Make a diagram. Show at least two ways impurities can be removed from water.



the problem:

Over 97% of the world's water is in the oceans. With population and freshwater use increasing, scientists are trying to find inexpensive ways to purify sea water. How can sea water be desalted?

clues for you:

Draw a quart of sea water from the shoreline or mix a salt solution. Let the sand settle and then taste the water.

You will need a still to complete this activity. You can make one (see card 33-3) or you can use a teapot and a hotplate. Place a small amount of the salt water in your still. If you are using the tea pot place a piece of glass over the spout. The water will condense and run down it. Collect the water in a glass.

When your still has produced some water, taste it. Does it still taste salty? Does it taste the same as tap water? Could this method be used to produce fresh drinking water for large cities? What are the disadvantages of this system?

Materials:

information cards, How to Build a Solar Still (33-3) and Commercial Desalination (33-1)

materials for still (see 33-3) or hot plate and teapot, piece of glass, container

other ways to look at it:

.. How is the procedure you used similiar to the water cycle?

.. Read up on the world's pure water problems. How may distillation of ocean water help solve this problem?

.. Are there any other ways to desalt or use salt water to produce fresh water? Read the information card on Commercial Desalination. How does this plant's operation compare to yours?

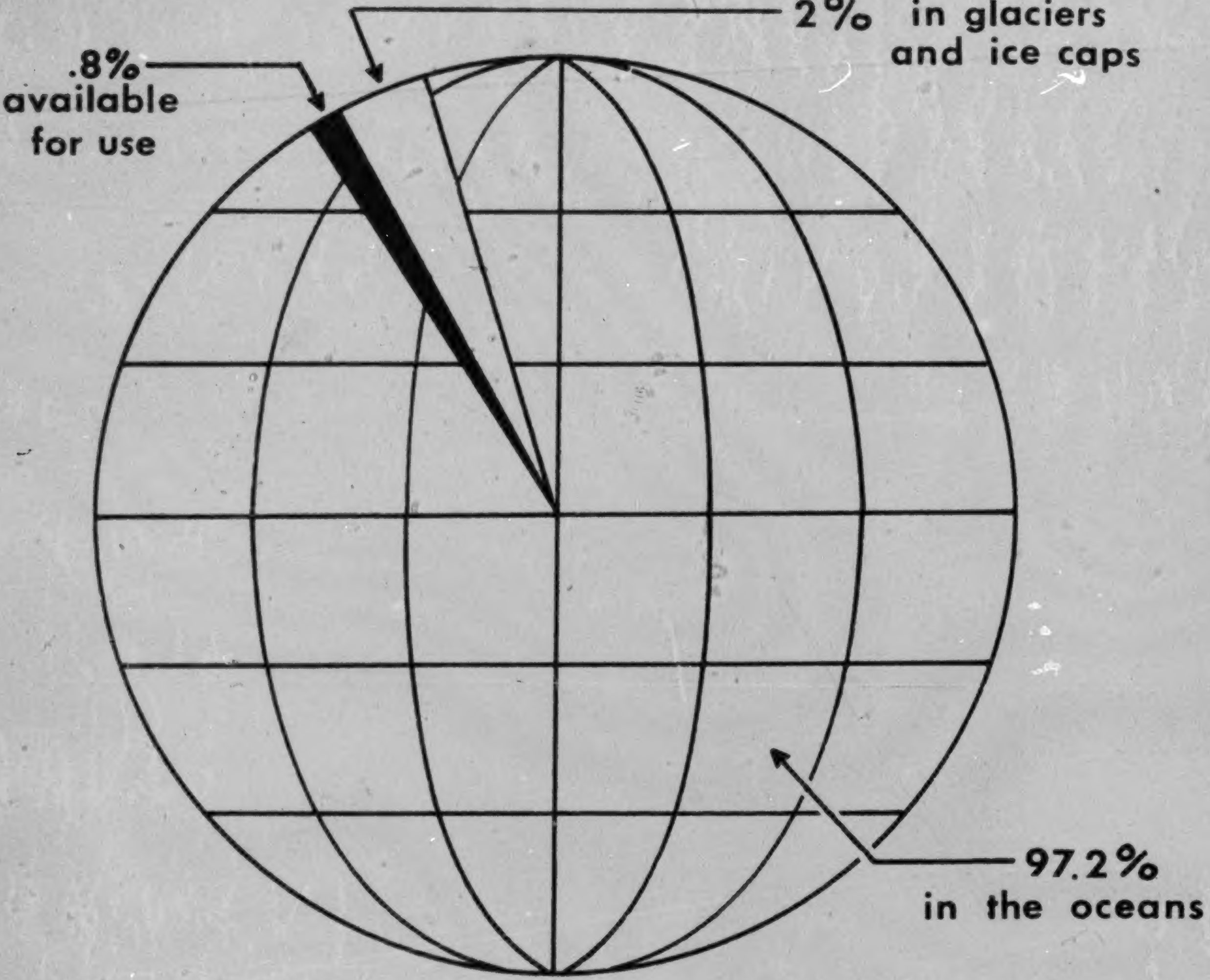
.. Does the desalination process produce a by-product? What is it? Can this be used to help pay for the desalination?

.. Read about the different methods used to get fresh water. Are there any desalination plants being used in your state?

what did you discover?

Display samples of both the water collected and the desalted sample — enough for your classmates to taste. Make a drawing of your purification process for display.

Distribution of Water on Earth



INFORMATION CARD

Commercial Desalination (de-sal-in-a-tion)

Desalination is the process of changing salt water into fresh water. This process has received more attention in the last few years. This is because our freshwater supplies may not be great enough for our growing population. Since over 97% of the earth's water is in the oceans, it is only natural for men to look there.

Desalination can be done in a number of ways. Basically the operations either remove the water or the salt. In your experiment, you removed the water by distilling it. Distillation (or evaporating and condensing) of salt water has been used for many years aboard ships. The ship's waste steam is used to distill the water. Several land-based stills have been built in dry regions, such as Kuwait. In oil-rich Kuwait, petroleum deposits provide a cheap source of fuel. These plants, however, have two disadvantages: they are slow and costly. The total output of these plants is not much more than that of a single, large, metropolitan waterworks plant.

At Freeport, Texas, the U.S. Office of the Interior operated a waterworks plant that distills seawater in four stages. The four stages are very much alike, but they operate at lowered temperatures and pressures. In this way, the steam produced in one unit becomes the source of heat for the next unit.

Water may also be separated from the salt by freezing. Freezing processes require less energy than distillation, but the cost of operation is much higher.

Salt can be removed from the water by forcing the salt through a membrane. This process is called osmosis. Again, the process is slow and costly.

In short, commercial methods of desalination have not yet become practical. They are too expensive and slow. This is an area that needs more research.

Questions for Thought

1. Why are people looking to the oceans for freshwater?
2. Why can't people drink salt water?
3. Why isn't desalination of salt water practical?
4. What is the main method of desalting sea water?

VOCABULARY

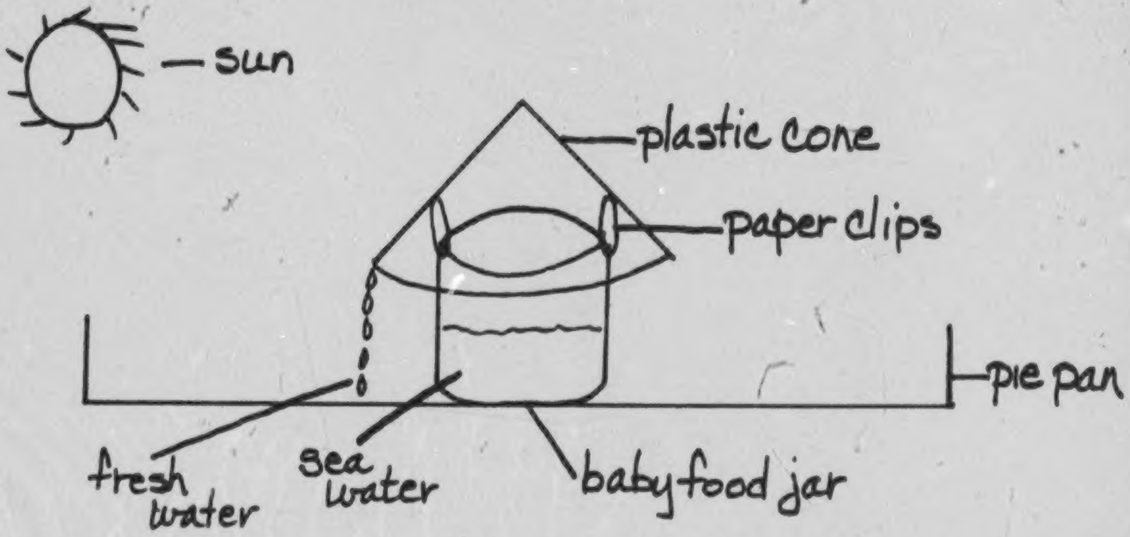
1. desalination: to take salt out of water
2. distillation: changing from a liquid to a gas by heating and then back to a liquid by cooling
3. metropolitan: city-like
4. membrane: a thin sheet of material that lets certain liquids and solids pass through
5. osmosis: passing of liquids through a membrane

INFORMATION CARD

How to Build a Solar Still

Materials:
sea water
plastic wrap
pie pan
paper clips
baby food jar

1. Make a cone shape out of the plastic wrap. It should be a little smaller than the diameter of pie pan.
2. Place three or four paper clips along the top of the baby food jar. Fill the jar about half-full with sea water.
3. Place the baby food jar in the center of the pie pan and put the plastic wrap cone on top of the jar. Place the still outside in the sun or on a sunny window sill. (A light can be used instead of the sun, but this destroys the idea of cheap power)
4. The cone should be just inside the edge of the pie pan and above the surface. Leave the still for several hours in the sun.



the problem:

How much do you know about your water supply?

clues for you:

Call, visit, or read about your local water treatment plant. Here are some questions to ask:

1. Where does my water come from?
2. How is the water treated before it reaches me?
3. How does the water reach my home?
4. Is there enough water for all the people in the area?
5. Will there be enough water if the population grows at the same rate? At a greater rate?
6. What are some special problems about water in this area?

Use your information in a class discussion on local water supplies.

Materials:

liquid soap	baby food jars
pH paper	hot plate

samples of tap water, rain water, well water

information cards, Water Sources in Brevard County (34-1) and Water Surpluses and Dificiencies (34-5)

other ways to look at it:

.. Try this: take some tap water. Boil it for a few minutes. Taste it when it cools. Then pour the water back and forth from one cup to another several times. Taste again. What changes the taste of the water?

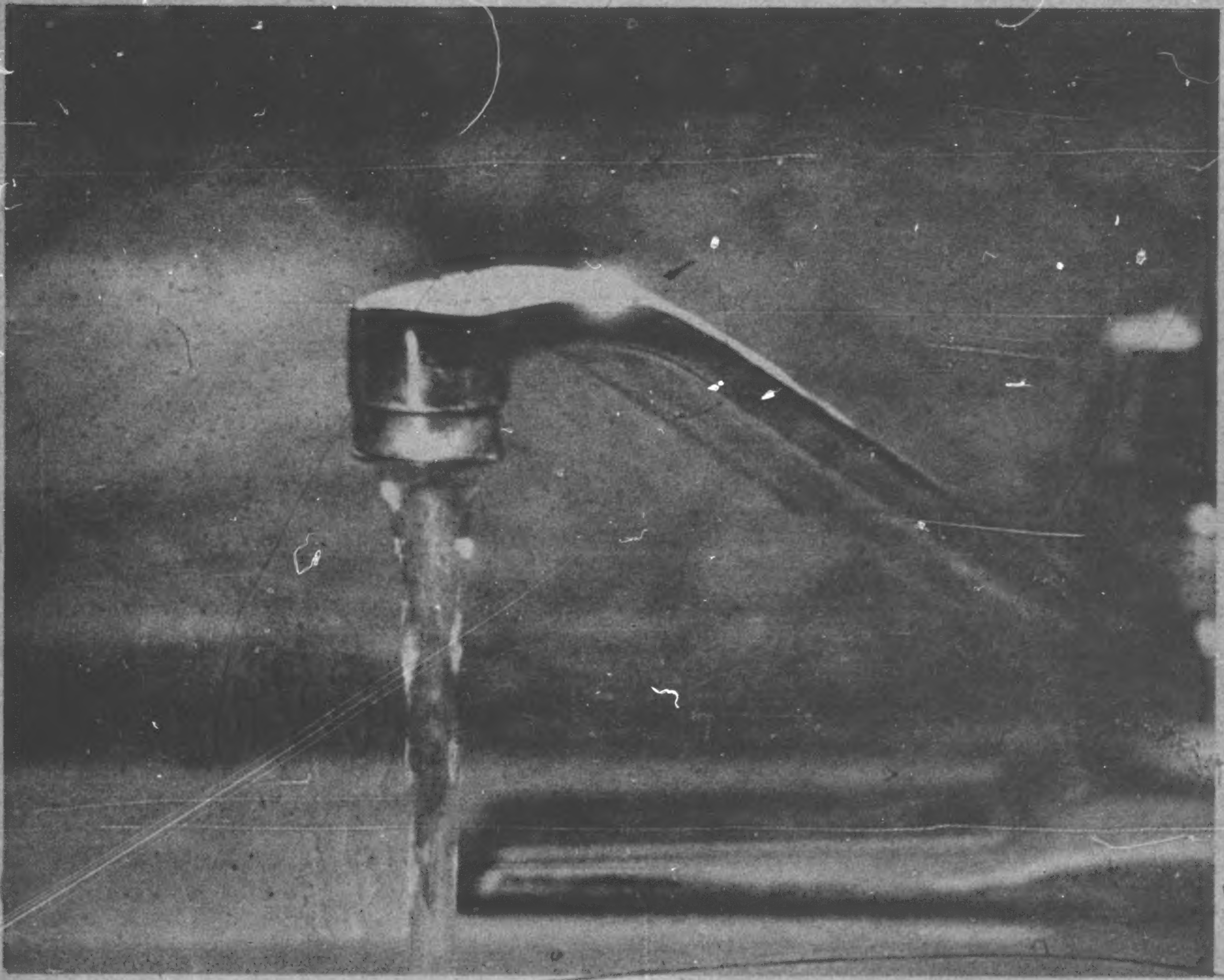
.. Get samples of rain water, well water, and tap water. Test each for hardness. Put a drop of liquid soap in small jars containing equal amounts of each type of water. Cap each jar. Shake each the same amount of time. What happens to each? (The hardest one will have the least amount of suds.)

.. Test the pH of rain water, well water, and tap water. Which has a pH closest to 7? (pH's lower than 7 are acid, higher than 7 are alkaline.)

.. Read the card Water Surpluses and Deficiencies. Will your area have enough water as the population grows? Predict areas that will not.

what did you discover?

Make a chart showing the flow of water in your area from its source to your home.



INFORMATION CARD

Water Sources in Brevard County

Before Brevard County's period of rapid growth (see activity card on population), most people took their water from shallow wells. These wells were easy to drill and inexpensive. The water, in many cases, was substandard: it was very hard and easily contaminated.

As the population of Brevard County grew, these shallow wells became unsatisfactory. At the present time there are four municipal systems, thirteen privately owned systems, two county owned systems and one industrial system.

Cocoa

The city of Cocoa has constructed 19 wells in a field 25 miles west of Cocoa. They average about 650 feet in depth and are capable of producing 28.5 million gallons per day (mgd). The well field and treatment plant are located in Orange County. There are two booster pump stations, one west of Cocoa and another east of Merritt Island. Storage tanks totaling 12.8 million gallons are scattered throughout the system.

The system supplies the cities of Cocoa, Rockledge, Cocoa Beach, Merritt Island, Cape Canaveral and Patrick Air Force Base. It contains approximately 450 miles of pipe.

Water is pumped from the wells to an aeration and chlorination plant. Aeration adds air to the water. This improves the taste of the water. Chlorine kills bacteria in the water and also adds to the taste. Chlorine does not give water a bad taste, only if too little is used.

The water then goes to the C. H. Dyal Treatment Plant for further treatment and softening. Lime is added to give the water a proper pH. This protects the water pipes from corrosion. Soda Ash is added to soften the water. Ammonia and carbon dioxide are added to stabilize the other chemicals. Fluoride is added to prevent tooth decay. The water is then pumped to storage tanks in the Cocoa area and finally reaches your home.

The City has an active master plan for system expansion to meet future demands of 70 mgd. Present problems faced by this system include increasing salinity of raw water and increasing demands for more water. Investigation and planning are proceeding in all problem areas.

Melbourne (including Eau Gallie)

The City of Melbourne operates two water treatment plants. They are located at Lake Washington. The treatment plants employ color removal, coagulation, sedimentation, filtration, taste and odor removal and disinfection. Coagulation, sedimentation, and filtration remove impurities. The former well supplies for Eau Gallie are kept in standby condition for emergency use. The system has storage tanks holding 8.8 million gallons. Patrick Air Force Base and West Melbourne receive their water from this system.

The City of Melbourne maintains a master plan to guide expansion and improvement of its water system. The main problem facing the system is the limited capacity of Lake Washington. This problem may be solved with the completion of the Upper St. Johns River Basin Project. Completion of the Project, however, is being held up until the Environmental Protection Agency completes a study of the impact of the project on the area.

Titusville

The water source for the City of Titusville is a system of shallow wells in the unconfined coastal aquifer. These wells are relatively low producers. The reliable yield of the aquifer is estimated to be about 18 mgd. Water treatment consists of coagulation, softening, rapid sand filtration, disinfection and storage. Storage capacity is 2.8 mg.

There are no transmission lines since the treatment plant and wells are located in a built-up area. They are between Interstate Highway I-95 and downtown Titusville.

Planning for water supply has been projected to the year 1983. Problems facing this system are the limited capacity of the individual shallow wells and the high iron content of the local water. Consideration is being given to the development of a new well field in the vicinity of Christmas. This would draw from the Floridan Aquifer. The Floridan Aquifer is a thick section of permeable limestone which contains water. This formation underlies nearly all of Florida.

The total county population served by the public water supplies is estimated to be 212,000. This leaves 38,000 people on private well supplies, or about 15 percent of the total.

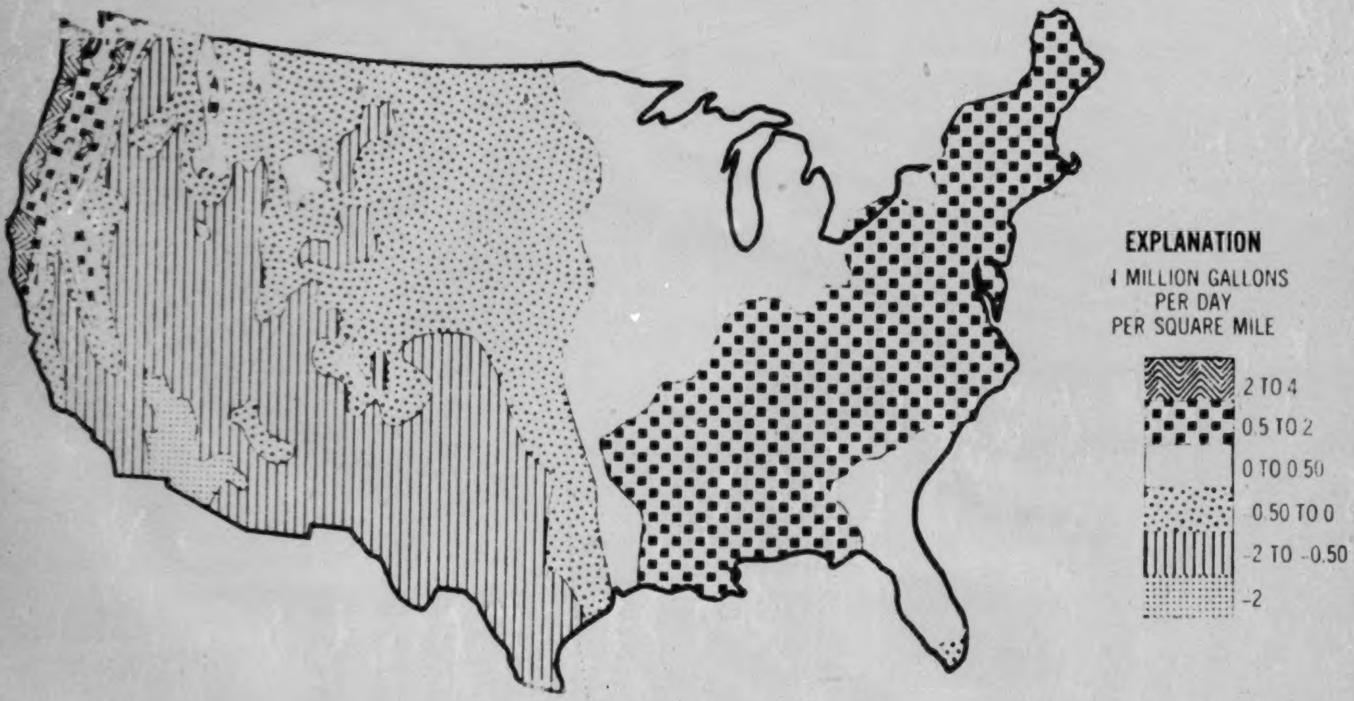
Basic Utilities Study, Part 1. Prepared by Ralph M. Parsons Company, 69.

VOCABULARY

1. inexpensive: reasonable in price
2. substandard: below the standards set for drinking water
3. contaminated: unclean, or not pure
4. aeration: adding of air
5. fluoridation: adding fluride to strengthen tooth enamel
6. disinfection: destroying harmful micro-organisms with chemicals
7. salinity: measure of salt in water
8. coagulation: to drive together, clot
9. sedimentation: settling out of particles, mud, silt
10. filtration: separating by filters
11. aquifer: underground layer of water
12. transmission: to carry something in another thing
13. permeable: can pass through

INFORMATION CARD

Water Surpluses and Deficiencies in the United States


EXPLANATION
1 MILLION GALLONS PER DAY PER SQUARE MILE
2 TO 4
0.5 TO 2
0 TO 0.50
0.50 TO 0
-2 TO -0.50
-2

Source: United States Department of the Interior, Has the United States Enough Water? (A. M. Piper), Geological Survey Water-Supply Paper 1797, 1965, Plate II.

Does your area have enough water? Study the map above. Do you think you will have enough water in 1980? How can an area that receives as much rainfall as southern Florida be running short of water?

There are two big reasons for water shortages everywhere. First, the population is growing at an alarming rate—all over the world. To see what has happened to the population of Brevard County, do the activity cards on population. Secondly, each person is using more water than ever before. The average person uses 50 gallons of water per day. This is four times as much water as the average person used in 1900. Use of water by industry and agriculture has increased six times since 1900. So more people are using more water; in fact, Americans are using water twice as fast as it can be replaced by the water cycle. This year alone, Americans will use over 300 billion gallons of water.

Southern Florida has some additional reasons for water shortages. Two-thirds of the rainfall for the county occurs from June through October. The water supply for southern Florida comes entirely from precipitation. During periods of heavy rainfall, much of the water runs off into storm sewers, canals and streams. The water is then mixed with salt water and is too salty for use in water supplies. Man has added to this problem by constructing more canals to drain the land.

The water that does soak into the ground may become very "hard." This means that the water has picked up minerals from the ground. Iron, sulfur, and salt are three minerals common in this area. These minerals must be removed before the water can be used.

Southern Florida is surrounded by salt water. It is underground, too. The more we use fresh water, the more the salt water creeps into the water supply. The two best ways to keep salt water out of our fresh water supplies is by storing fresh water in surface reservoirs and by putting salt water barriers in canals and streams. The force of the fresh water keeps the salt water back.

Southern Florida cannot afford to waste water. As the population grows, water will become more scarce.

problem:

How much water does your family use?

es for you:

er usage per person per time:

a bath	30 gallons
a shower	20 gallons
g a toilet	3 gallons
g face or hands	2 gallons
ng teeth	¼ gallon
g	¼ gallon
g dishes	8 gallons
g a meal	5 gallons
washer	32 gallons

p a record each day for one
f all the times the members of
amily use water. Figure out how
water your family uses each
low much water does your
use in a week? In a month?
ar?

ials:

ation card, Saving Water (35-1)
ok
ter bill

other ways to look at it:

.. Get a copy of your water bill. Most water bills express the amount of water used in thousands of gallons. Does this amount agree with the amount you found your family used? What happened to the additional water?

.. Do you have any leaking faucets? Put a container under a dripping faucet. Figure out how much water is wasted in an hour. How much is lost in a day?

.. Read the information card, Saving Water. Make a list of the ways your family could save water. Try these methods. See if they work.

.. The average cost of water in some areas is about 0.00037 cents per gallon up to 5 thousand gallons. The rate decreases the more water you use. Does this help to save water?

t did you discover?

Post the amount of water your family used in one day and in one week.
npare this with other members of your class. Total up how much water is
d by the families of your class.

YOU'R

USING WATER
FASTER THAN NA
CAN REPLACE I

the amount of
stays the sa

UT...

1 the POPULATION GROWS

UP in 1950 150 million
UP in 1970 204 million
UP by 1980 237 million
in USA

asia, africa, latin america
greater increases

2 MORE U PER PER

dishw
pools
baths
lawn
disposals

per person u
UP 4 TIME
since 1900 in

INFORMATION CARD

Saving Water

We use four times as much water in our homes now as in 1900. The average daily water use per person in the U. S is 50 gallons. In areas of the world where people draw their own water, the average daily use per person is three to five gallons.

Saving water is a family project; it takes everyone's cooperation. First, make a list of all the appliances and fixtures in your home that require water. Don't forget items outside -- like lawn sprinklers.

Now, make a list of the ways you can save water for each item on your list. You should be able to thaink of many ways to save water. Much of the water that goes through your home is never really used, just wasted.

One of the largest areas of water waste is the bathroom. Many people use the toilet as a wastebasket, but you are using over five gallons of water each time you flush it. Try adjusting the float in the tank so the toilet takes less water (better let Dad help here). If the float isn't adjustable, add a brick to the toilet tank -- it takes up space and saves water. A leaky toilet can waste as much as sixty gallons per day. Make sure yours doesn't leak. Check the faucets in the tub and sink -- do they leak? A simple rubber washer may solve that. Don't leave water running when you brush your teeth or wash your face. If you take a shower, don't make it a long one. You are wasting water again!

Mom may need help saving water. Appliances like dishwashers and washing machines should be run with full loads. Don't ask your mother to run the machine for that special item you have to have -- plan ahead!

Have your family plan ways to save water -- then try it! You will save money and water at the same time.

Saving Water

VOCABULARY

1. cooperation: wveryone helping
2. appliances: household machines such as washer, dishwasher, etc.
3. adjusting: fitting things to one another

the problem:

How does man use water?

clues for you:

Read the information card, Stop the World, I Want to Get Off! Then answer these questions.

1. How does man use water?
2. Why is there a limit to the amount of water man can use?
3. Who are the biggest users of water?

Visit an industry or service in your community (or invite a representative to visit your class). Find out:

1. How they use water.
2. How much water they use.
3. How their waste water is discharged.
4. How they treat their waste water.

Materials:

Information cards, Stop the World, I Want to Get Off! (36-1) and Brevard's Oyster Industry May be Dying Out (36-4)

notepad or clipboard, paper, pencil
crayons, glue, scissors

other ways to look at it:

.. Make a chart. Show the ways water is used in your community. Indicate approximate amounts.

.. Try designing or setting up a balanced aquarium or terrarium. How is the recycling of all plant and animal wastes done naturally within this closed environment?

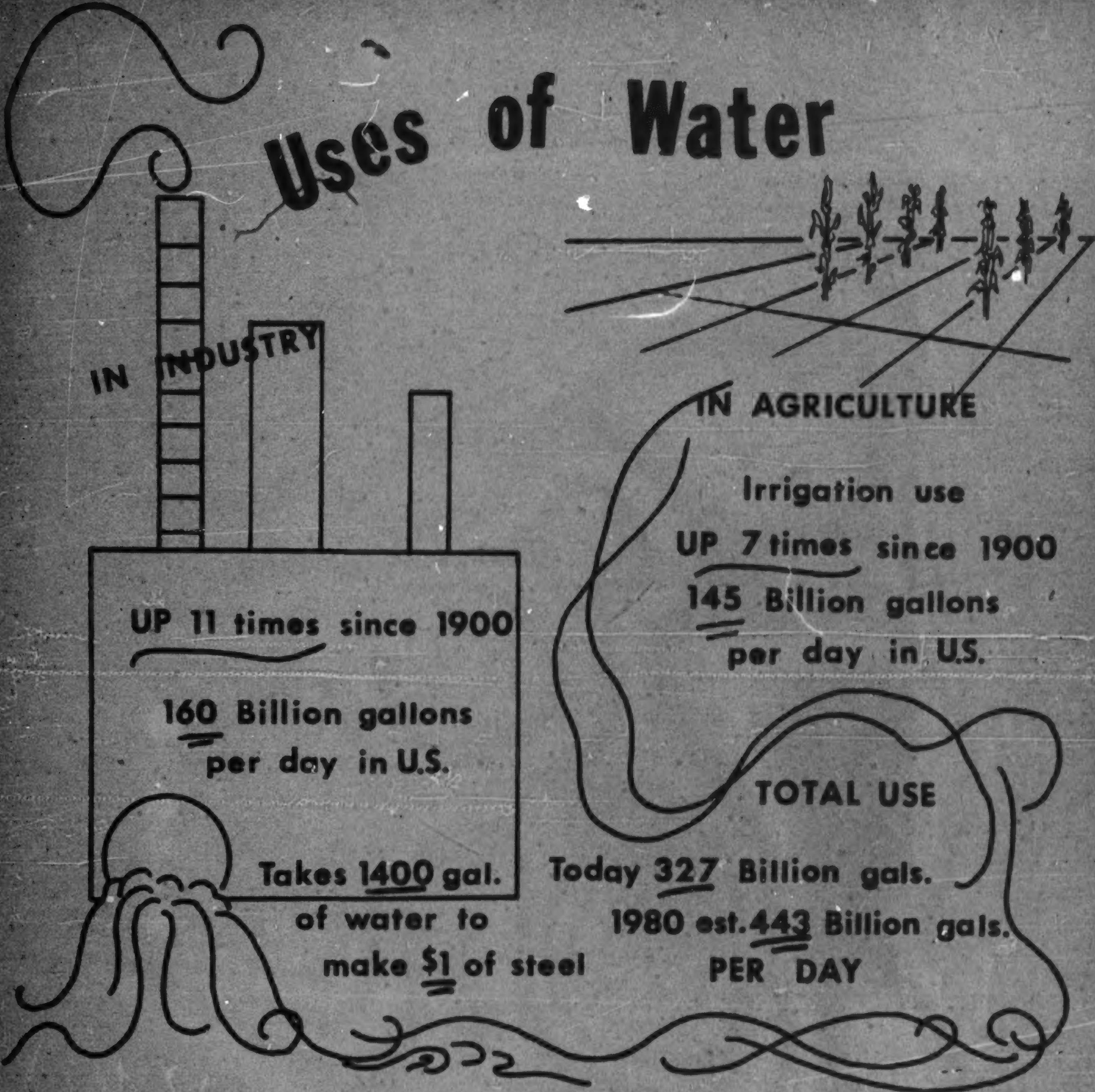
.. Look through old magazines for pictures of water being used in different ways. Make a collage of your pictures.

.. Read the information card, Brevard's Oyster Industry May be Dying Out. How does this industry depend upon a supply of both fresh and salt water? What other area industries depend upon a constant supply of water?

.. How does the use of water pollute it?

what did you discover?

Make a chart listing all the different uses of water you found from each business. Draw pictures or make sketches of these uses.



Uses of Water

IN INDUSTRY

UP 11 times since 1900

160 Billion gallons per day in U.S.

Takes 1400 gal. of water to make $1 of steel

IN AGRICULTURE

Irrigation use UP 7 times since 1900

145 Billion gallons per day in U.S.

TOTAL USE

Today 327 Billion gals.

1980 est. 443 Billion gals.

PER DAY

INFORMATION CARD

Stop The World, I Want To Get Off!

We can compare the planet earth with vehicles such as the Skylab space station and the submarine, Mautilus. All three are "closed" systems. In their travels, each carries its own, limited life-support systems. Nothing new is ever added. Of course, with the case of the spaceship and submarine there is always the re-entry and the return to home port.

What saves man (and all living things) from poisoning himself comes in the form of natural recycling. Plant and animal wastes and water are recycled, or reused. Nature recycles all things at its own pace. Water evaporates by the sun's heat and floats in invisible doplets into the air to make clouds. This same water comes back to earth as rain, snow, hail, sleet, or dew. About 30% of this falls directly back into the oceans. The remainder nourishes plants and trees, trickles over rocks and into rivers. An important fraction of this surface water becomes ground-water. It is stored in rock formations in underground reservoirs. What's left flows into the oceans or rivers. The rain that you got caught in on your way home from school is actually part of the same water that fell on dinosaurs 70 million years ago!

The rain on earth falls in a fairly unchanging quantity. The population, however, doubles, then triples. There are more people crowding our biosphere (Los Angeles has already drunk a 25-by-20 mile lake dry). Each person is also using more water in this modern society. With more bathrooms, garbage disposals, washing machines and lawn sprinklers, Americans are now using four times as much water as they did in 1900.

The steel and paper-pulp industries are among the heaviest users (and polluters) of the world's water supply. In producing a ton of steel, a mill uses over 27,000 gallons of water. This is enough water to fill a large backyard pool. That's about 1400 gallons for $1.00 worth of steel. The paper and wood-pulp mills use about 6.5 million gallons of water every day. To give you an idea of how much water this is, the Cocoa tower holds 1.5 million gallons.

Industry makes close to 60 TRILLION gallons of waste water a year in meeting the demands of consumers.

Large amounts of water are also needed for sanitation services in local communities. Great quantities are used by sewage treatment plants. It is used in treating the sewage waste, dilluting the effluent, and flushing away the wastes.

And all of this is on its way back to the oceans. The water cycle is a pretty constant thing. It recycles water at the same rate it did back in 1900.

Man may have reached the point where nature cannot handle this recycling burden. A man-in-nature balance has to be made. It may mean changing habits or reducing the standard of living. The closed environment of this biosphere must not poison its inhabitants. Remember, unlike the Skylab or the Nautilus, man cannot stop and get off.

VOCABULARY

1. reservoirs: place where water is stored
2. effluent: flowing out
3. inhabitants: residents

Brevard's Oyster Industry May Be Dying Out

As recently as 1970, the Brevard County oyster industry produced some 139,000 pounds of oyster meat. In 1972, this production had dropped off to 52,498 pounds. Some members of the shellfish industry have declared that oyster farming may disappear completely from the Brevard scene within the next few years.

What has caused this dramatic change? There are two major sources of the problem -- increased water pollution, and decreasing supplies of freshwater for the oyster beds.

Oysters are extremely sensitive creatures. They require very special conditions in their habitats. Water pollution from untreated or inadequately treated sewage can destroy an oyster bed, or reduce its productivity. Water running into the streams after a rain also contains pollutants. These make the oysters unharvestable.

Pollution is not the only threat. Oysters grow best when the salinity (salt level) of the water is about 15 parts per thousand (ppt). This is because they are protected from most of their natural enemies. When salinities reach 18 ppt or above, the oyster's enemies are able to invade the oyster beds and reduce the crop.

The 15 ppt salinity level is much lower than the average salinity of seawater. Levels of 15 ppt are achieved only when freshwater flows constantly over the oyster beds. It mixes with the salt water and dilutes it. If the flow of freshwater is reduced, the salinity level is likely to rise to the point where the oyster's enemies can move in.

Normally, the estuaries at Port Malabar and Sebastian Inlet usually maintain salinity levels which are favorable for oyster production. The problem is that these areas are no longer IN their natural condition. Rapid development has placed a heavy demand on fresh water. It is often diverted to form canals. This makes for nice waterfront homes, but it reduces the flow of freshwater to the oyster beds. As a result, the salinity levels at many of Brevard's oyster beds have risen to 25 or 30 parts per thousand. The oyster production has dropped accordingly.

The obvious question is, can Brevard have its residential development and its oysters too? This may be possible, but it will require very careful management of water resources and better sewage treatment. It will also require good long-range planning for both water use and land use.

-- Beacham, Frank, Assistant Metro
Editor, Today Newspaper,
"Pollution Shells Oyster Industry,"
and "New Way A Pearl," July 7, 73

Question for Thought

1. Outline a plan which would preserve the oyster industry in Brevard County without stopping the county's growth. What would be the most important ingredients in your plan?

VOCABULARY

1. dramatic: very clearly presented; easy to observe
2. habitat: the place (environment) where something lives
3. inadequate: not good enough
4. productivity: the amount that something can produce (make)
5. salinity: the salt concentration of water (the amount of salt in a given quantity of water)

   Note: Make sure you are in command of this concept, as the whole article revolves around it.
6. prolonged: lasting
7. diverted: moved away from, channeled
8. accordingly: in response to something; as a result of it
9. residential: having to do with homes (residences)

the problem:

What happens to the water you use?

clues for you:

Study the student information card, Waste Water Treatment. Then, try to visit a sewage treatment plant in your area. Make a list of questions to ask the sanitation engineer. You might want to include these:

- What percent of the organic pollutants are removed by this treatment?
- How many homes was this plant designed to serve (or how many gallons per hour)?
- How many homes is the plant now serving?
- What plans have been made for a population increase?
- Where is the treated sewage discharged?

Materials:
student information cards, The Water-Cleaning Machine (37-1) and Waste Water Treatment (37-4)

other ways to look at it:

.. Read the student information card, The Water-Cleaning Machine. Show how natural processes purify the water.

.. How do the processes used in a sewage treatment plant compare with the natural processes for purification?

.. Sketch the path waste water takes from the time it leaves your home until it returns to use. Is the water from storm sewers combined with sewage from homes? What happens during periods of heavy rain?

.. Find out about the tertiary treatment of sewage. Is there any plant in your area that has tertiary treatment of sewage? How does it work? What are some uses of sewage sludge?

.. How does untreated sewage affect plants and animals in the water?

.. Who checks the operation of sewage plants?

what did you discover?

Diagram the treatment necessary for waste water to be reused.

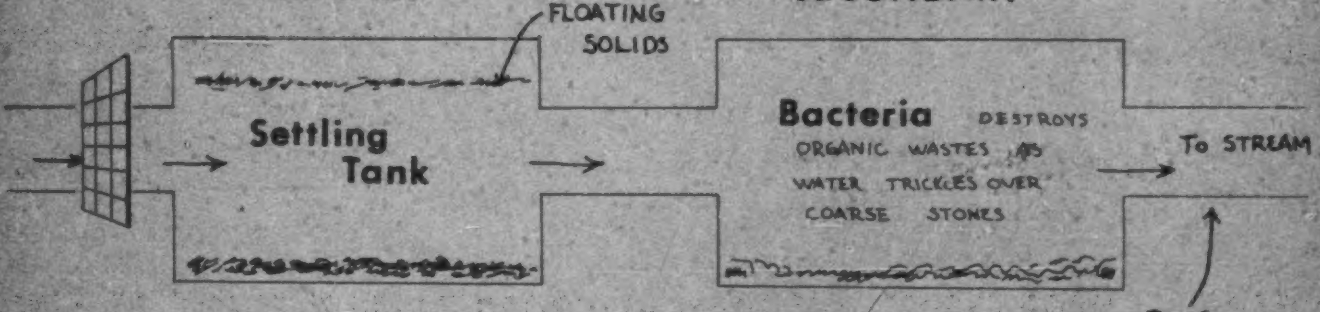
HOW USED WATER CAN BE TREATED TO BE USED AGAIN—

15% OF MUNICIPALITIES HAVE ONLY

PRIMARY ?

75% OF MUNICIPALITIES HAVE

SECONDARY



FLOATING SOLIDS

Settling Tank

Bacteria DESTROYS ORGANIC WASTES AS WATER TRICKLES OVER COARSE STONES

To STREAM

SCREENING OUT STICKS, RAGS, ETC.

SETTLING SOLIDS

PLUS CHLORONATION

--Removes **35 %** ORGANIC POLLUTANTS FROM SEWAGE WATER

--REMOVES UP TO **90 %** OF ORGANIC POLLUTANTS

OVER **1200** MUNICIPALITIES WITH SEWERS DUMP WASTES INTO RIVERS AND STREAMS UNTREATED

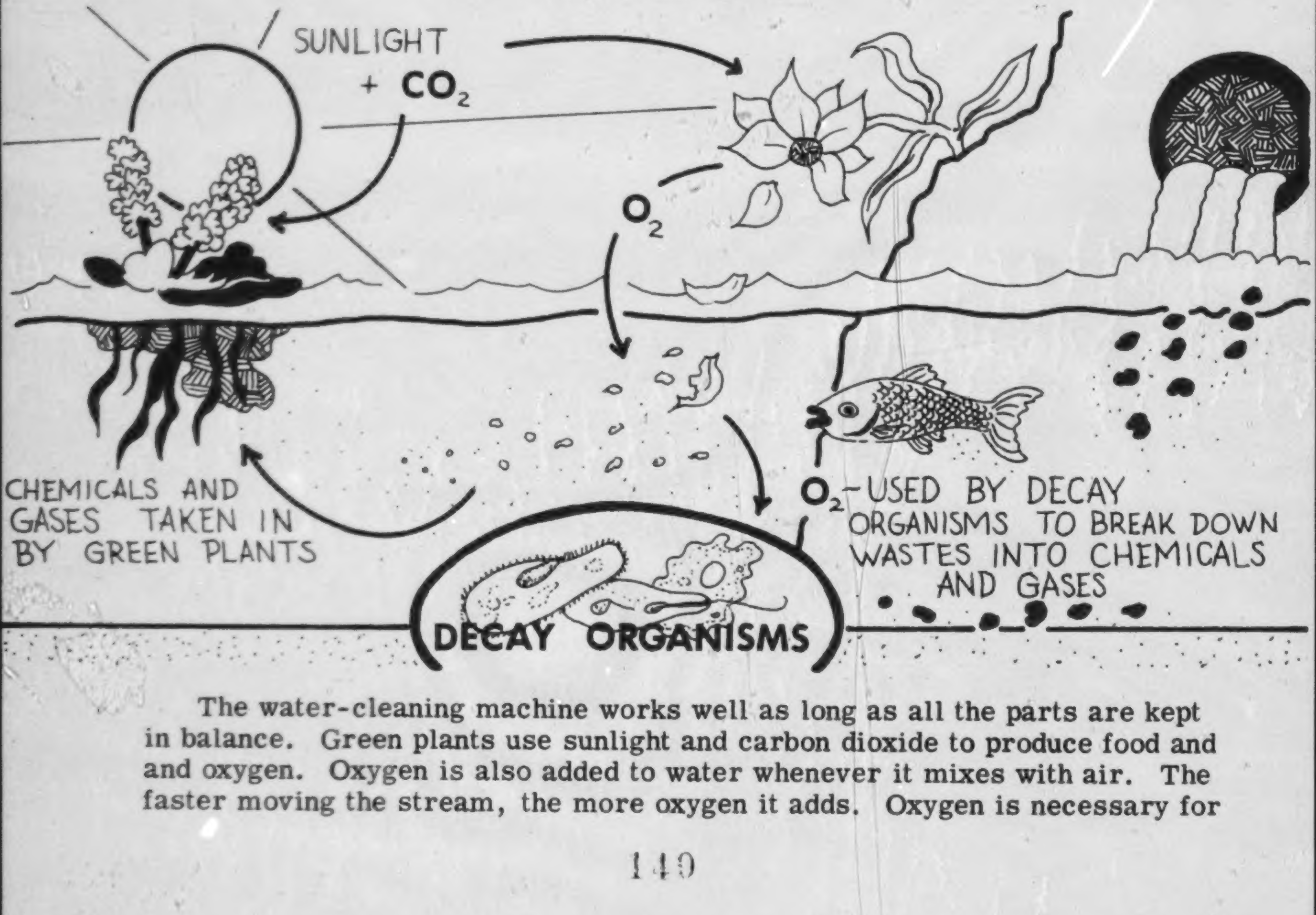
60 million people IN U.S. USE WELLS FOR WATER, AND CESSPOOLS OR SEPTIC TANKS FOR WASTE.

INFORMATION CARD

The Water-Cleaning Machine

Every living thing on Earth needs water. Water is everywhere--in the air, in our bodies, in the earth's crust. The amount of water on Earth remains constant. We do not get more water. We use the same water over and over. We are able to do this because water is self cleaning.

The Water-Cleaning Machine


SUNLIGHT
+ CO_2
O_2
CHEMICALS AND GASES TAKEN IN BY GREEN PLANTS
O_2-USED BY DECAY ORGANISMS TO BREAK DOWN WASTES INTO CHEMICALS AND GASES
DECAY ORGANISMS

The water-cleaning machine works well as long as all the parts are kept in balance. Green plants use sunlight and carbon dioxide to produce food and and oxygen. Oxygen is also added to water whenever it mixes with air. The faster moving the stream, the more oxygen it adds. Oxygen is necessary for all animal life in the water. The animals in the water use the oxygen and food from the plants. They give off carbon dioxide and waste. One form of life found in the water is bacteria. The bacteria are called decomposers. They feed on the waste materials and break them down into chemicals and gasses which can be used again.

As the amount of waste in the water increases, the number of bacteria will increase. Thi is because there is more food for them. As the bacteria multiply, the amount of oxygen needed increases. The amount of oxygen that body of water needs is called the "biological oxygen demand," or BOD.

Sometimes large amounts of waste are dumped into the water. The machine becomes overloaded. Everything goes wrong. Here's how it works. First, the number of bacteria increases. More bacteria need more oxygen. Sometimes the plants cannot produce enough oxygen. The animals die. The bacteria die. The waste materials are no longer being broken down. The plants die. All activity in the water stops. It is dead.

The death of a stream does not always happen this way. Sometimes the streams become over-fertilized. Phosphates, the chemicals in fertilizers and laundry detergents, cause the plants to grow. The plants grow too rapidly. They soon choke off their own sunlight. Then they die. This process is called eutrophication.

Man affects the water in other ways. Pesticides are washed into the water. The don't kill the plants or animals, but they are not broken down. The deadly chemicals are absorbed into the tiny plants and animals. They are passed along the food chain. This can also happen with metals like mercury.

Man also uses water to cool things. This heats the water. This may cause the plants to grow more rapidly. If the heat is too much, the plants and animals may be killed.

Nature has a good water-cleaning machine. Like any other machine, it doesn't work when it is overloaded.

Source: Sopis, Kenneth and Josephine. Spaceship Earth: Danger! Danger! Danger? New York: Holt, Rinehart, Winston, 1973.

VOCABULARY

1. constant: always there
2. bacteria: microscopic things (protista)
3. decomposers: animals which break down things into smaller parts
4. phosphates: a salt containing the element phosphorus, found in fertilizers and detergents
5. eutrophication: speeding up the natural aging process of a lake
6. mercury: a metal element which is a liquid at room temperature

INFORMATION CARD

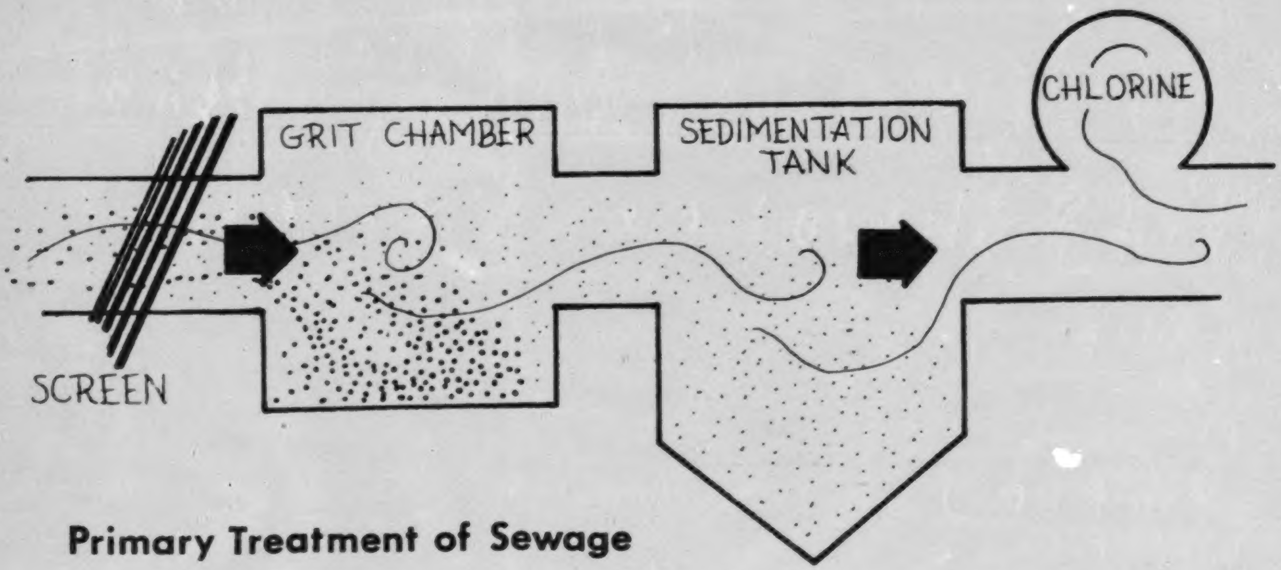
Waste Water Treatment

Waste treatment plants clean waste water. They speed up the natural processes by which water is purified (see The Water Cleaning Machine). The amount of waste that man produces is too great for nature to handle. This is why waste treatment plants are necessary.

Waste treatment varies from city to city. Over 1000 communities in the U. S. do not treat their waste water. They dump their untreated waste back into the open water.

Thirty percent of the communities in the U. S. give their sewage only primary treatment. Primary treatment removes about 1/3 (35%) of the organic pollutants from the water. (Organic pollutants are those which come from living things.) This process is not satisfactory for most needs.

In primary treatment, solids are allowed to settle. Then they are removed from the water. This is the way primary treatment works:



Primary Treatment of Sewage

As the sewage enters the plant, it flows through a screen of some type. The screen removes large objects that might clog pipes or pumps. The sewage then passes into a grit chamber. There sand, grit, and small stones are allowed to settle to the bottom. Grit chambers are important in cities where storm sewers are combined with sewage. The sewage next flows into a sedimentation tnak. Here the flow of the sewage is slowed. Very small particles settle to the bottom. The layer that forms on the bottom of the tank is called sludge. It must be removed from the tank when it builds up. Finally, chlorine gas is added to the remaining liquid. The chlorine gas kills some of the disease causing bacteria. It also reduces odors.

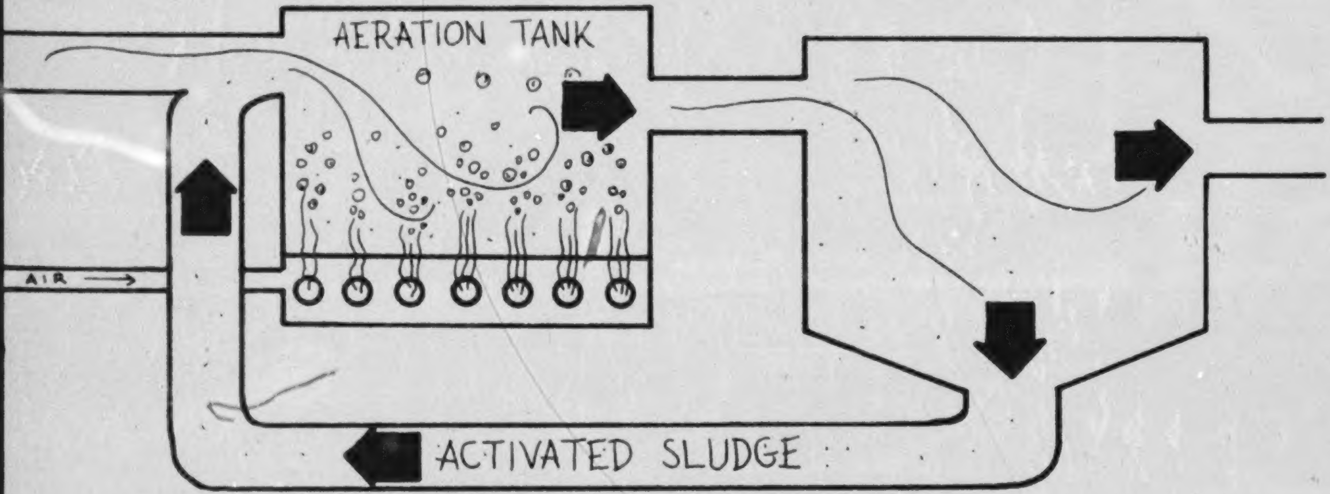
Most of the communities in the U.S. give their sewage secondary treatment. Secondary treatment removes up to 90% of the organic pollutants. It does this by making use of bacteria. There are two main types of treatment: trickling filters and activated sludge.

A trickling filter is simply a bed of stone through which sewage passes. It comes there after undergoing primary treatment. The filter may be three to ten feet thick. Bacteria gather and multiply on these stones. They break down most of the organic matter in the sewage. The cleaner water trickles out through the pipes in the bottom. It then receives chlorination to complete the treatment.

More modern plants use activated sludge process for secondary treatment. This process brings air and sludge together. This speeds up the work of the bacteria. It also brings great numbers of bacteria from the sludge into contact with the sewage.

The activated sludge process works like this. First, the sewage receives primary treatment. Then it is pumped into an aeration tank. There, the sewage is mixed with air and sludge. The sludge is loaded with bacteria. The great amount of oxygen in the tank helps the bacteria. It speeds their work. The mixture stays in the tank for several hours. During this time, the bacteria change organic waste into useful chemicals.

Outflow from the tank is chlorinated. This completes the secondary treatment. Chlorination here can kill up to 99% of the harmful bacteria.



Secondary Treatment of Sewage (Activated Sludge)

Some communities add an extra step. It is called tertiary treatment. They do not dump the treated water back into streams. Instead, they use it as fertilizer. The organic materials left in the liquid are used by plants. The liquid seeps down through the soil. It eventually becomes part of the ground water. Sewage treated in this way does not pollute streams.

Source: A Primer on Waste Water Treatment. Washington: Environmental Protection Agency, 1971.

Waste Water Treatment

VOCABULARY

1. grit: small, stony particles
2. sedimentation: deposit of sediments such as dirt, sand, and clay
3. sludge: mud, sediment from sewage disposal
4. chlorine: an element, a yellow gas with a very strong odor.
5. aeration: adding air
6. tertiary: the thirds, in sewage treatment the third process to clean sewage before dumping

the problem:

Clean water: who's responsibility is it?

clues for you:

Read the information cards, Water Quality Standards, We Need Clean Water, and Local Standards.

Who has the greatest responsibility for setting water quality standards? For enforcing local water quality standards? What are our national goals for water quality?

Invite someone from your local health department to talk to the class. Find out what the role of the health department is in relation to clean water. How do they locate polluters? Who prosecutes them? Have them explain to the class what action citizens can take to prevent pollution of their water.

Materials:
information cards, Water Quality Standards (38-1), Local Standards (38-3), and We Need Clean Water (38-4)

other ways to look at it:

.. What is your local government doing to defend your water against pollution? What civic and private organizations are active in fighting for clean water? Find out what they do.

.. Study the cover of this card. Does your state have approved water quality standards? Do the states near you?

.. What does the EPA do besides set standards for clean water?

.. Make a scrapbook of clippings from your local newspaper on local, state, and national water problems. What are some of the severe problems in your area?

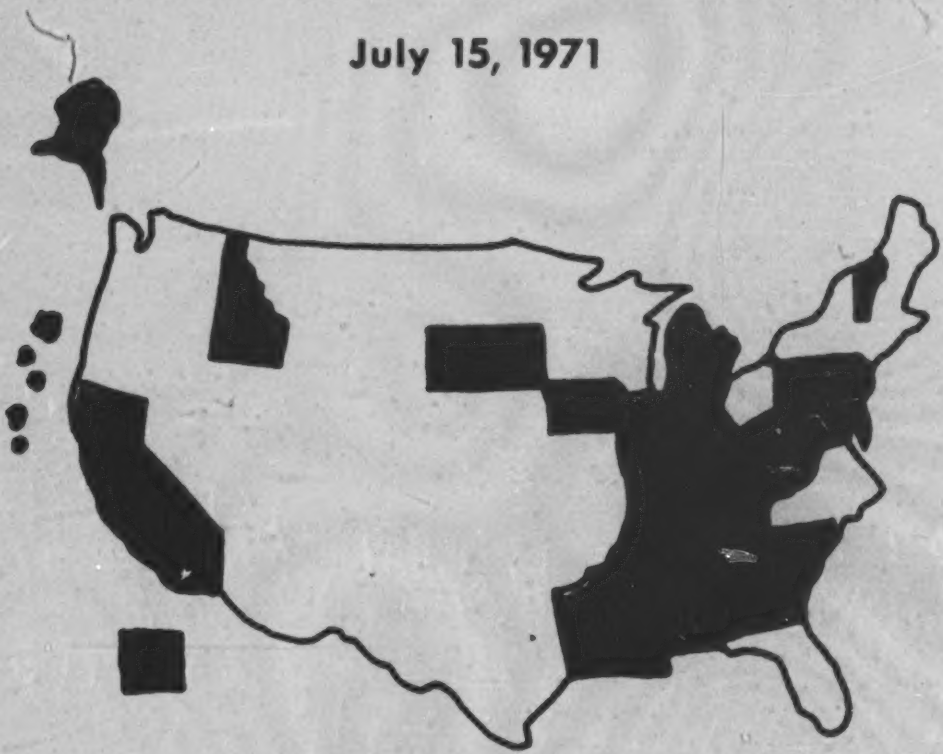
.. How are these laws enforced? Reread the information cards to see if you can find out. What should you do if you suspect that someone in your area is polluting the water?

what did you discover?

Make a chart comparing the responsibilities of the local, state, and federal government concerning water quality standards. Where do you fit in the picture?

APPROVED WATER QUALITY STANDARDS

July 15, 1971



☐ States with approved water quality standards inc. antidegradation

■ States with approved W. Q. S. without antidegradation

■ States with partially approved W.S.Q.

Gain of 16 states with antidegradation

WATER QUALITY STANDARDS

FIGHTING WATER POLLUTION ON 3 FRONTS

FEDERAL GOVERNMENT

- PROVIDES FUNDS TO HELP COMMUNITIES BUILD WASTE TREATMENT WORKS
- GRANTS TO STATE WATER POLLUTION CONTROL PROGRAMS
- RESEARCH FOR BETTER WASTE TREATMENT
- ENFORCEMENT OF FEDERAL POLLUTION LAWS
- WORKS WITH STATES TO ESTABLISH AND ENFORCE "WATER QUALITY STANDARDS TO PREVENT POLLUTION
- LONG RANGE COMPREHENSIVE PROGRAMS FOR WATER POLLUTION CONTROL IN MAJOR RIVER BASINS
- TECHNICAL ASSISTANCE TO STATES ON POLLUTION PROBLEMS

STATE GOVERNMENTS – PRIMARY RESPONSIBILITY FOR WATER POLLUTION CONTROL

EVERY STATE HAS **LAWS** TO CONTROL POLLUTION AND **AGENCIES** TO ADMINISTER THESE LAWS.

STATE AGENCIES--

- ESTABLISH AND ADMINISTER WATER QUALITY STANDARDS
- COLLECT AND ANALYZE DATA ON WATER SUPPLY AND POLLUTION WITHIN STATE
- GIVE TECHNICAL AID TO COMMUNITIES AND INDUSTRIES SEEKING WAYS TO TREAT WASTES
- REVIEW PLANS FOR LOCAL SEWAGE PLANTS AND CHECK OPERATION OF PLANTS
- PROVIDE FUNDS FOR TREATMENT PLANT CONSTRUCTION

INDUSTRY... HAS DEVELOPED NEW MANUFACTURING PROCESSES TO CONSERVE WATER AND WITH FEDERAL HELP, IS STEPPING UP RESEARCH ON INDUSTRIAL WASTES.

HAVE FORMED GROUPS TO WORK TOGETHER TO CONTROL POLLUTION

LOCAL GOVERNMENT 38-2

1ST LINE OF DEFENSE IN BATTLE AGAINST WATER POLLUTION

COMMUNITIES MUST TREAT WASTES PROPERLY BEFORE DISCHARGING INTO WATERWAYS.

LOCAL PLANTS MUST BE STAFFED BY TRAINED PERSONNEL

NEW HOUSING DEVELOPMENTS AND INDUSTRIES MUST HAVE PROPER SEWAGE AND WASTE DISPOSAL FACILITIES

GOOD COMMUNITIES HAVE...

- ADEQUATE SEWER SYSTEMS
- SEWAGE TREATMENT PLANTS WITH SECONDARY TREATMENT
- ADEQUATE AND PROPERLY TRAINED STAFF
- PLANS FOR NEW SEWERS AND TREATMENT PLANTS AS COMMUNITY GROWS
- INDUSTRIES WHICH ARE DOING THEIR PART IN KEEPING UNTREATED WASTES OUT OF STREAMS

SOURCE: CLEAN WATER, EPA

FOR MORE INFORMATION

FEDERAL

WRITE TO:

ENVIRONMENTAL
PROTECTION
AGENCY

OFFICE OF WATER PROGRAMS
WASHINGTON, D.C. 20460

STATE

WATER POLLUTION
CONTROL AGENCY
IN
YOUR STATE CAPITAL

LOCAL

WRITE OR PHONE OR VISIT

1. YOUR MAYOR
2. YOUR WATER DEPARTMENT OR CITY ENGINEER
3. YOUR HEALTH DEPT.
4. CIVIC, CONSERVATION, OR WOMEN'S ORGANIZATIONS

INFORMATION CARD

Local Standards

- Establishing rules . . .

In Florida, the board of county commissioners has the authority to set rules which will prevent and control air and water pollution within the county.

- Enforcing standards . . .

The board on county commissioners and the State Board of Health are given the authority to enforce local standards. In an emergency, the board of county commissioners can get an injunction to stop the pollution.

The board must approve construction of or addition to sewage plants and sewage systems.

- Prosecuting violators . . .

Any person who violates the local standards is notified by registered mail. The violator then has fifteen (15) days to take action and file a report or to apply for a hearing before the board. The board then decides whether or not the person is in violation and orders any action to be taken.

VOCABULARY

1. authority: someone in charge
2. injunction: a legal command not to do something
3. registered: recorded in a book

We Need Clean Water

Not so many years ago, most streams and lakes in America were sparkling and clean. People could swim and fish in them without being afraid of becoming sick. As our nation grew bigger, we built towns and factories on the banks of these streams and lakes. Every year we dumped more and more wastes into them.

Marine scientists have found that even the ocean depths show the effects of pollution. In shallower waters near our coasts, contamination prevents the harvesting of fish and shellfish in many areas. Oil--accidentally spilled or deliberately dumped in the ocean--has become a big problem. It spoils our beaches and destroys fish and sea birds.

The water that we drink is ordinarily taken from the best and least polluted source. It is then treated to make sure it is safe for drinking. But you can see that with so much pollution, it gets more difficult to find good water and to make sure that it is properly treated. Even water far below the ground, is sometimes polluted by poisonous wastes seeping into the soil.

Where does all this water pollution come from? Here are some of the most important facts:

- More than 1,416 communities discharge their sewage into waterways without any treatment whatever. More than 2,300 communities use just primary treatment, which removes only 30 to 40 percent of some pollutants.
- The largest amount and the most poisonous of pollutants come from industrial plants.
- Big oil spills from vessels and from off-shore drilling have caused serious damage.

Huge feedlots, contained areas where thousands of cattle or other animals are fattened for the market, cause a problem. Animal wastes seep into the ground and get into waterways.

- Fertilizer and pesticides run off from our fields and forests.

- Wastes from mining operations drain into the water.

- Water, principally used to cool electric power generators, is put back into streams still hot from the power plants.

- Sewage from big ocean liners and small pleasure boats is dumped into our waters.

The Federal government began its efforts to clean up the Nation's waters in 1948. The early Federal program was changed several times over the years. It was then revised and greatly strengthened by Congress in 1972. Here are some of the ways EPA now fights water pollution under the Federal Water Pollution Control Act:

- EPA gives money to communities to help them build sewage treatment plants.

- EPA helps train men and women to design and operate sewage treatment plants.

- EPA gives money to the States to help them carry on their water pollution control programs.

- EPA establishes various standards to make sure that water pollutants from factories and community sewage treatment plants do not harm our health.

Some standards set limits on the amounts of pollutants that may be discharged into the water. Some standards define how factories and sewage treatment plants can operate with a minimum of water pollution.

- To make sure that clean water will be achieved, the Federal law prohibits discharges of pollutants into the water without a permit. Permits are issued by EPA, or by a State government if EPA approves the State's permit program.

The permit is a most important part of the water pollution control program. Each permit applies various standard to a specific polluter.

A permit for discharging pollutants is like a contract between the government and a polluter. It requires the polluter to reduce his discharges to meet government standards. It contains clear deadlines for action. And all permits are made public, so anyone can find out if polluters are living up to the conditions of their permits on schedule.

EPA also sets standards to control sewage discharges from ships and boats (except small ones, like canoes and rowboats). EPA also sets standards for the cleanup of oil spills and other hazardous substances. EPA can require anyone spilling oil or other hazardous materials into the water to pay the cleanup costs.

Anyone violating the water pollution control law may be fined up to $25,000 a day and be given one year in prison. In emergencies, EPA has the power to take whatever action is necessary to stop or prevent water pollution that is an immediate danger to people's health.

EPA's water pollution control programs require polluters to use what the law calls the "best practicable" technology for controlling water pollution by July 1, 1977. It also requires them to use the "best available" control methods by July 1, 1983.

The combination of strict standards, good technology and fair, but firm enforcement should enable the United States to achieve two goals established by Congress for our waters. The first goal is, whenever possible, water that is clean enough for swimming and clean enough for fish and wildlife by July 1, 1983. The second goal is no more discharges of any pollutants into our streams, rivers, lakes and oceans by 1985.

Source: *Your World, My World*. Washington: Government Printing Office, 73.

VOCABULARY

1. EPA: Environmental Protection Agency
2. specific: special, definite
3. hazardous: full of danger
4. practicable: possible to do, necessary

the problem:

Air is a mixture of certain elements and compounds. It includes oxygen and carbon dioxide. Are there certain conditions that will cause the amounts of these gases to increase or decrease?

clues for you:

Read the information cards, Oxygen-Carbon Dioxide Exchange and Carbon Dioxide. Make a list of all the activities mentioned that reduce the amount of carbon dioxide (CO_2) in the air. Make a second list of all the activities that add CO_2 to the atmosphere. Decide why the amount of CO_2 in the air is increasing. What effect will an increase in the amount of CO_2 have on the atmosphere? What effect will it have on plants? On animals?

Make a drawing. Show how the things you listed above fit into the oxygen-carbon dioxide cycle. Use arrows to show how the gas one thing produces is used by another. Show why a balance is important.

Materials:

hydrogen peroxide
baking soda
wood splint
glass beaker
yeast
vinegar
matches
test tubes
water
information cards, Oxygen-Carbon Dioxide Exchanges (39-1) and Carbon Dioxide (39-2)

CAUTION: A FLAME IS NECESSARY FOR LIGHTING THE WOOD SPLINT

other ways to look at it:

.. Prepare a beaker half full of water. Put a pinch of yeast in a test tube. Fill it full with hydrogen peroxide. Quickly stopper the tube with your thumb. Turn the tube upside down. Put the mouth of tube under the water in the beaker. Release your thumb. Wait as the bubbles collect in the top of the tube. Light a wood splint. Blow it out so that it glows. Quickly raise the tube out of the water. Insert the glowing splint. What happens? The gas produced was oxygen.

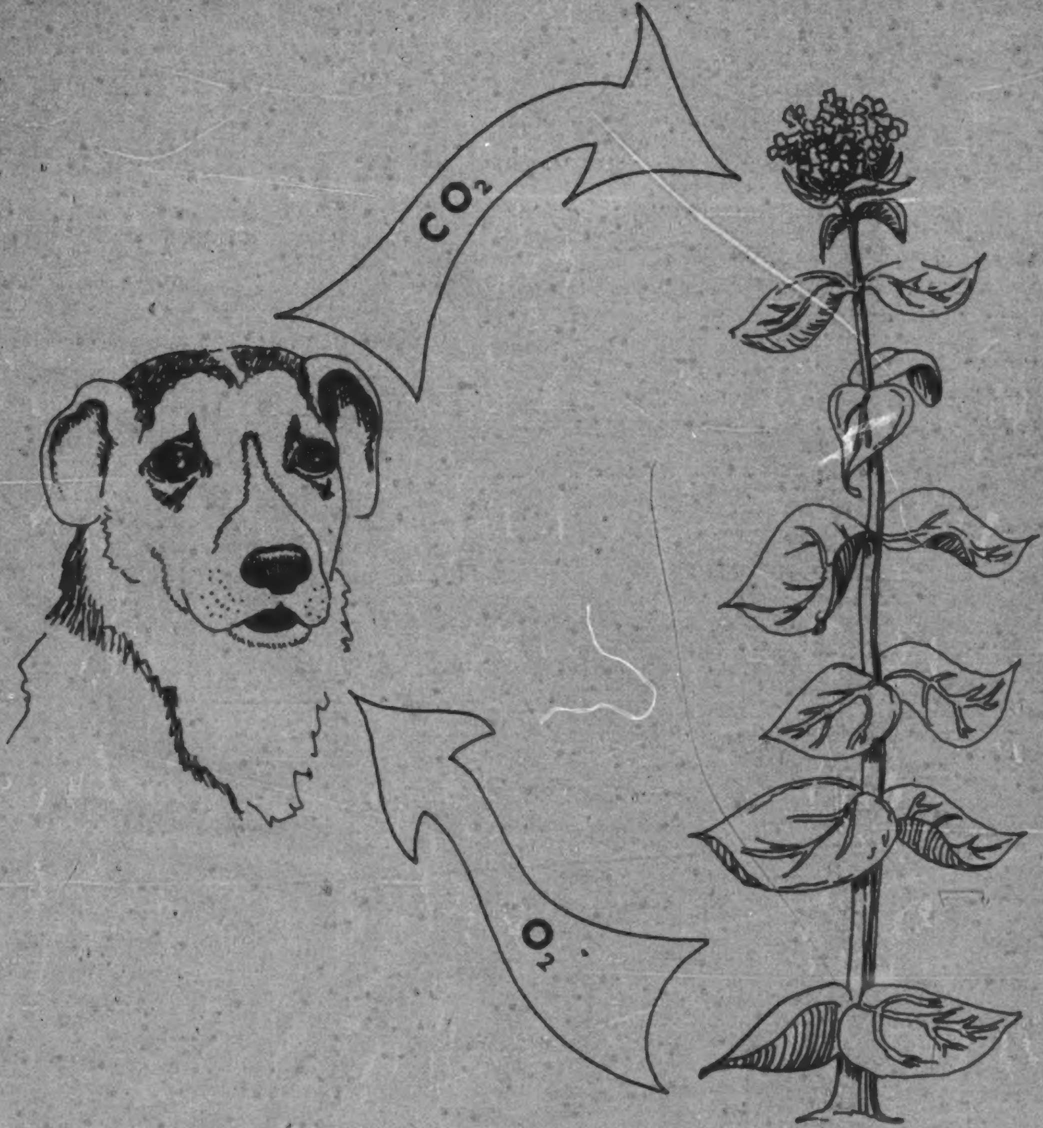
.. Repeat the procedure. This time place baking soda in the test tube. Fill it with vinegar. Test the gas with a flaming splint. What happens? The gas produced was carbon dioxide. What else could carbon dioxide be used for?

.. Some aerosols may be damaging the atmosphere. Find out why.

.. How are plants and animals dependent on each others' by products?

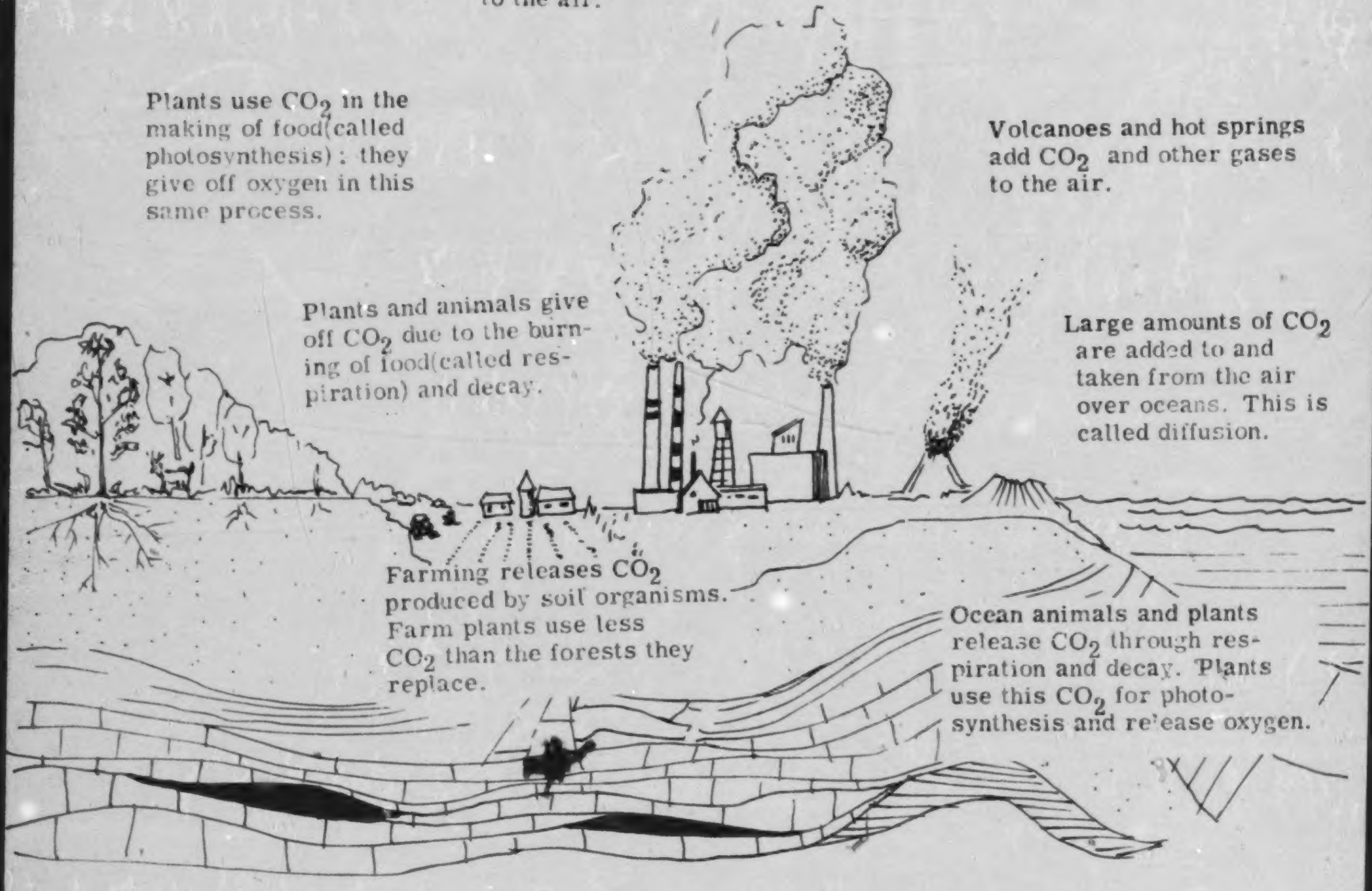
what did you discover?

Draw a diagram. Show how oxygen is used and produced in the natural environment. Show also how carbon dioxide is used and produced.


CO2
O2

INFORMATION CARD

Oxygen-Carbon Dioxide Exchange



Burning carbon fuels for energy uses up oxygen and adds a large amount of CO_2 to the air.

Rain washes CO_2 from the air to form carbonates(CO_3), which are carried to the oceans.

Plants use CO_2 in the making of food(called photosynthesis) : they give off oxygen in this same process.

Volcanoes and hot springs add CO_2 and other gases to the air.

Plants and animals give off CO_2 due to the burning of food(called respiration) and decay.

Large amounts of CO_2 are added to and taken from the air over oceans. This is called diffusion.

Farming releases CO_2 produced by soil organisms. Farm plants use less CO_2 than the forests they replace.

Ocean animals and plants release CO_2 through respiration and decay. Plants use this CO_2 for photosynthesis and release oxygen.

Dead plants and animals that are covered may gradually become coal or oil.

Carbonates(CO_3) sink to the bottom of the ocean, forming layers of limestone which store CO_2.

INFORMATION CARD

CARBON DIOXIDE

The earth is surrounded by an ocean of air. The air is really a mixture of gases. You probably know the names of some of them. Carbon dioxide -- the gas that bubbles out of soda pop -- is one of the gases in the air. This gas is formed when one atom of carbon (C) combines with two atoms of oxygen (O_2). Scientists write it CO_2 (C-O-2).

If you took a gallon jar of air from the atmosphere, you would only find $\frac{1}{4}$ of a teaspoon of CO_2. That doesn't seem like much. But this is more than scientists found 100 years ago. They have found that the amount of CO_2 has been slowly increasing. No one is certain just what effect this increase will have.

The diagram on the front shows how carbon dioxide is produced and used up. Almost everything -- except man -- takes as much CO_2 from the air as it adds to it. The extra CO_2 the scientists have been measuring comes mainly from man's activities over the last 200 years.

After the steam engine was invented, man began to burn carbon fuels for energy. Coal, oil, wood, and gasoline are all carbon fuels. When these fuels burn, the carbon combines with oxygen (from the air) and energy is released. CO_2 and water are also formed. We add about 6 billion tons of CO_2 to the air each year from burning carbon fuels. (In the past 100 years, we have probably added about 360 billion tons of CO_2 to the air this way.)

Farming adds CO_2 to the air - about 2 billion tons of CO_2 per year. Farm plants take out less CO_2 than the forests they replace. The cleared soil also contains tiny animals that release CO_2.

Some of the CO_2 that is added to the atmosphere is taken up by plants. This makes them grow faster. The oceans may also be taking up a little of the extra CO_2.

the problem:

Every year, over 280 million tons of wastes are released into the air over the United States. What are these pollutants? Where do they come from? How do they affect us? What can be done about this problem?

clues for you:

Study the information card, What's in the Air? What pollutants are in the air? Make a bar graph showing the percentages of each pollutant in the air.

Read the information card, We Need Clean Air. Make a second graph showing the sources of pollutants in the atmosphere. What is the largest polluter?

Make a chart to show the effects of each pollutant on the environment. Include the way it affects plants, animals, and nonliving things.

Make a list of things that can be done to reduce air pollution. Compare this with the action being taken by the Federal Government.

Materials:
information cards:
What's in the Air? (40-1)
We Need Clean Air (40-2)
Local Standards (38-3)
graph ditto, pencils, ruler, crayons

other ways to look at it:

.. Keep a scrapbook of local sources and incidents of air pollution. Find out what the clean air requirements are in this area.

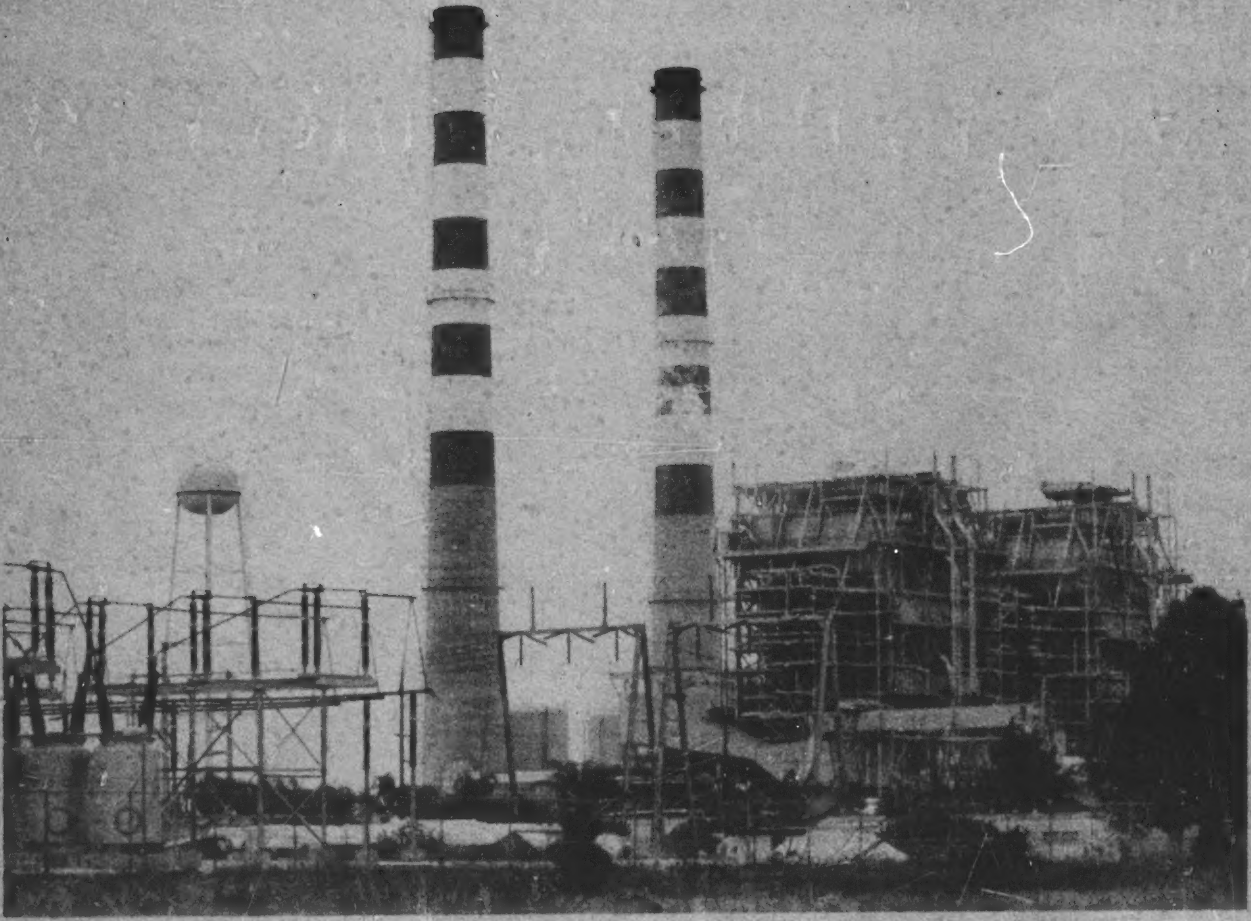
.. Whose responsibility is it to set and enforce standards in your area? Read the information card, Local Standards.

.. Sometimes a temperature inversion traps pollutants near the ground. When this happens, smog occurs, and people suffer from the pollutants. Find out what weather conditions can cause smog. Look for articles about smog in the newspaper.

.. Pretend that you are the mayor of Los Angeles and a dense blanket of smog covers the city. What emergency measures would you take to safeguard the people? What long-range measures would you take? Let your classmates take the parts of industry spokesmen, scientists and civic leaders. Discuss solutions to the smog problem.

what did you discover?

Compare the list of measures to reduce air pollution you drew up with those of your classmates. Draw up a class list of recommendations. Send it to our county commissioners.



WHAT'S IN THE AIR?[1]

Pollutant	Percentage	Description
Carbon Monoxide	47%	This is an odorless, colorless gas. It is often found in tunnels, closed garages, and near heavy traffic. It is produced when fuels containing carbon are incompletely burned. Carbon monoxide replaces oxygen in the blood. Large amounts can be deadly. Small amounts cause dizziness, headaches, fatigue, and slowed reactions.
Sulfur dioxides	15%	The burning of coal and oil containing sulfur produces these poisonous gases. They irritate the eyes, nose, and throat. They damage the lungs. They also kill plants, destroy metal and reduce visibility.
Nitrogen oxides	10%	These gases are produced by burning fuels. They produce a smelly, dark haze that irritates the eyes and nose.
Hydrocarbons	15%	These are produced mostly from unburned fuels during combustion. Large amounts are also produced as tires wear. Hydrocarbons are known to produce cancer. They also react with nitrogen oxides and sunlight to produce smog.
Solid particulates	13%	Dust, smoke, soot, ash—all these are examples of solid matter in the air. They darken the sky and fall out onto many objects. Solid particulates also intefere with normal breathing.

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[1] Information adapted from Probing the Natural World, Volume 3. Intermediate Science Curriculum Study. Morristown, New Jersey: Silver Burdett, 1972.

INFORMATION CARD

We Need Clean Air

- Where does air pollution come from?

The dark smoke you see coming from smoke stacks is one kind of air pollution. There are many other kinds you cannot see. Together they make up the serious air pollution that is threatening us.

Every year, over 280 million tons of wastes are released into the air over the United States. This is where they come from:

- 51% from transportation (mainly the internal combustion engines that power our automobiles and planes)
- 15% from burning fuel in furnaces and generators
- 14% from industrial processes
- 4% from burning trash and other solid wastes
- 15% from forest fires and miscellaneous sources

- What kind of pollutants are there?

Pollutants in the air include particulate matter, sulfur dioxides, carbon monoxide, hydrocarbons, and nitrogen oxides. More information about each pollutant is given on the information card, What's in the Air? Sometimes these pollutants combine to form new ones. Nitrogen oxides combine with gaseous hydrocarbons to form smog. Sunlight must be present. Smog is often trapped near the ground and forms a brownish haze over the city.

Air pollution can travel from city to city. It even spreads from one country to another. Some northern European countries have experienced "black snow." It is caused by pollutants that have traveled through the atmosphere. Environmental pollution is really a global concern.

- How does air pollution hurt us?

It affects your health. Each year, people die from air pollution. It kills babies, old people and those who have respiratory diseases. Air pollution increases lung diseases. Emphysema, bronchitis, and asthma are on the increase. Air pollution reduces visibility. It can cause both airplane and auto accidents. There are other health dangers that are being studied.

Air pollution costs money. It soils and corrodes buildings. It damages farm crops and forests. It destroys air treasures. The damage in the United States alone is estimated to be $16 billion each year.

• • What is the government doing about air pollution?

The Federal government began to do research on air pollution in 1955. In 1970, Congress authorized the EPA to set national clean air standards. This is the way the federal government is fighting air pollution:

•EPA set national air standards in 1971. They define how much of each pollutant will be allowed in the air. There are two kinds of standards. Primary standards are those necessary to protect our health. Secondary standards are those necessary to prevent undesirable side effects.

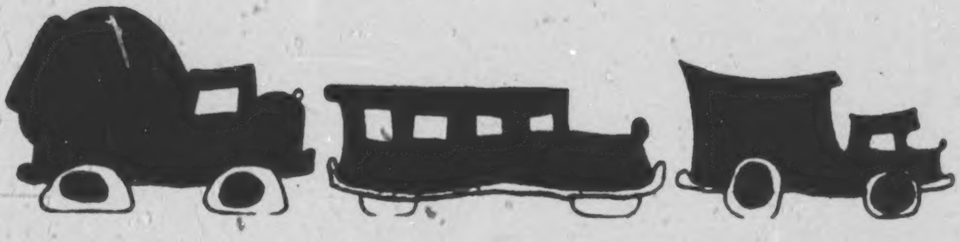
•States and territories must meet national standards. Primary standards must be met by mid 1975. All states must submit plans which show how these standards will be met. If the state fails to do the things in its plan, the EPA can step in and see that they are done.

•EPA has established emission standards for certain industries. These require plants to use the best possible methods to keep pollution to a minimum. They tell the plant exactly what can come out of its stacks.

•EPA has proposed standards for beryllium, mercury, and asbestos. These materials are extremely harmful to human health.

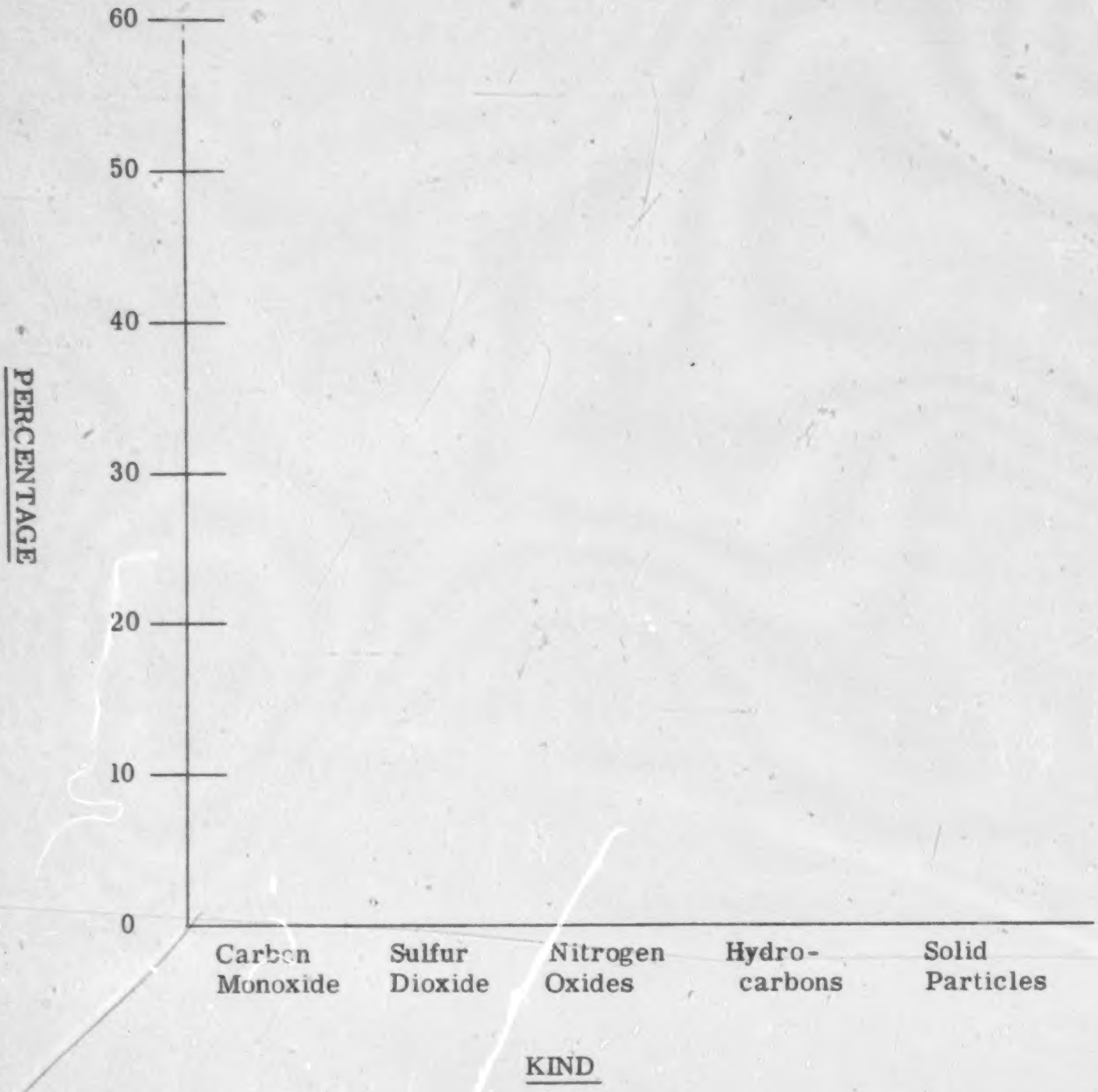
•EPA sets and enforces emission standards for all new cars. Since 1968, all new cars have been required to reduce pollution levels. EPA is doing research and encouraging research on less polluting automobiles.

You can see that we can't cure air pollution must by ordering everybody to stop polluting. If we did that, most of our factories and power plants would have to close down, and we couldn't even drive our cars. But we can clean up our air in the next few years if we are all willing to change our ways of doing things—ways that cause air pollution—just as quickly as we can.

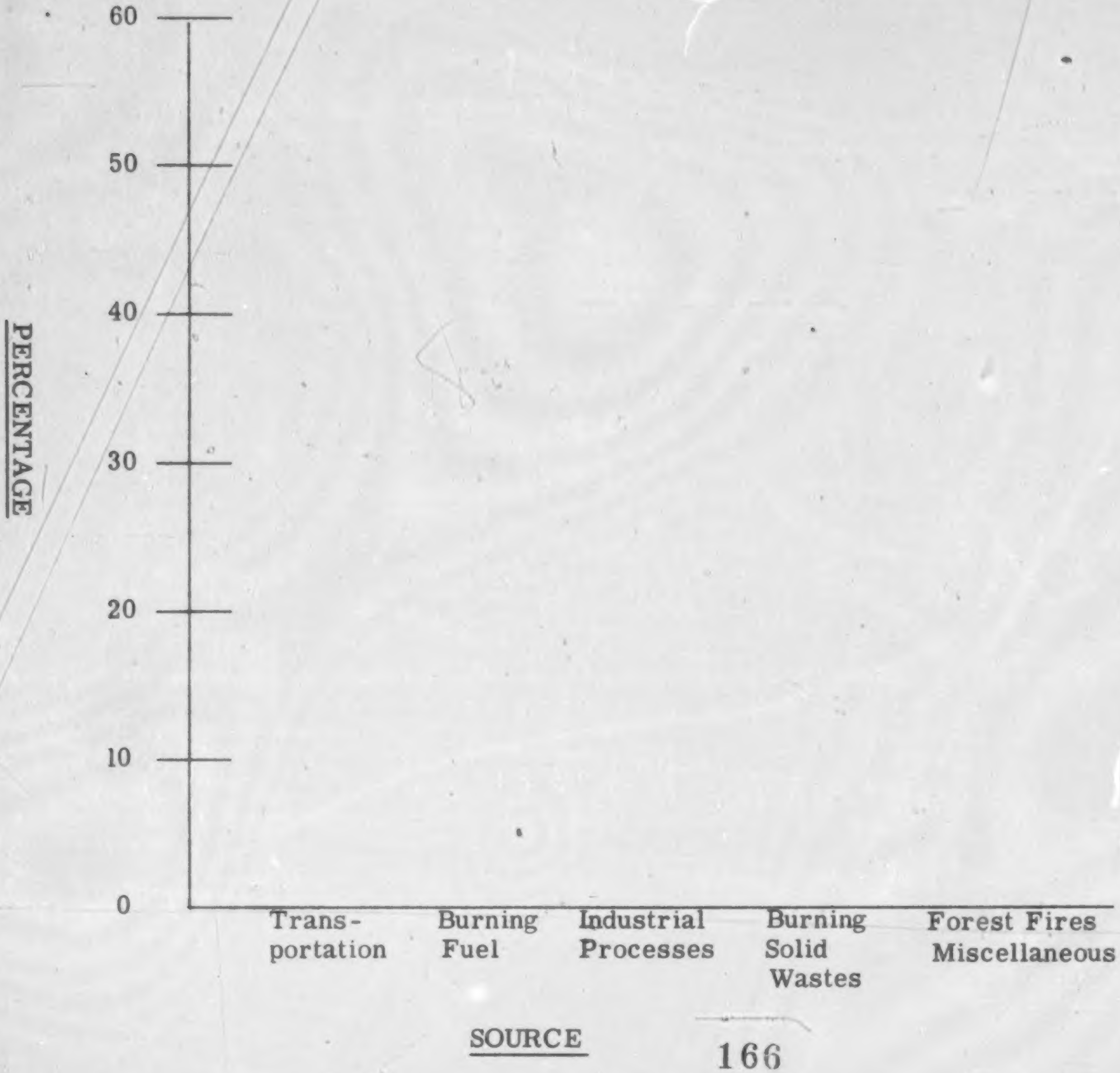


Source:
Your World, My World. Washington: Government Printing Office, 1973.

KINDS OF AIR POLLUTANTS



SOURCE OF AIR POLLUTANTS



the problem:

Can you measure air pollution?

clues for you:

Take several white index cards marked in 1" squares. Coat each with a very thin covering of petroleum jelly. Anchor the cards to something steady and place them in various locations around school or home. Make a map of the area to show where you located the cards. Try to find areas which you think will have large amounts of pollutants and areas which will not have much pollution. Leave the cards for at least 24 hours.

Use a hand lens or a microscope with top lighting and count the number of particles in each 1" square. Make a chart showing the number of particles by the square inch in each location.

Materials:

Information card, What's in the Air (40-1)

ruler
hand lens
microscope
index cards
petroleum jelly

other ways to look at it:

.. Try to devise another method for measuring the amount of particles.

.. Try to identify some of the particles you have collected. Are there some types of pollution in the air that this method would not indicate? What other types of pollution exist in the air?

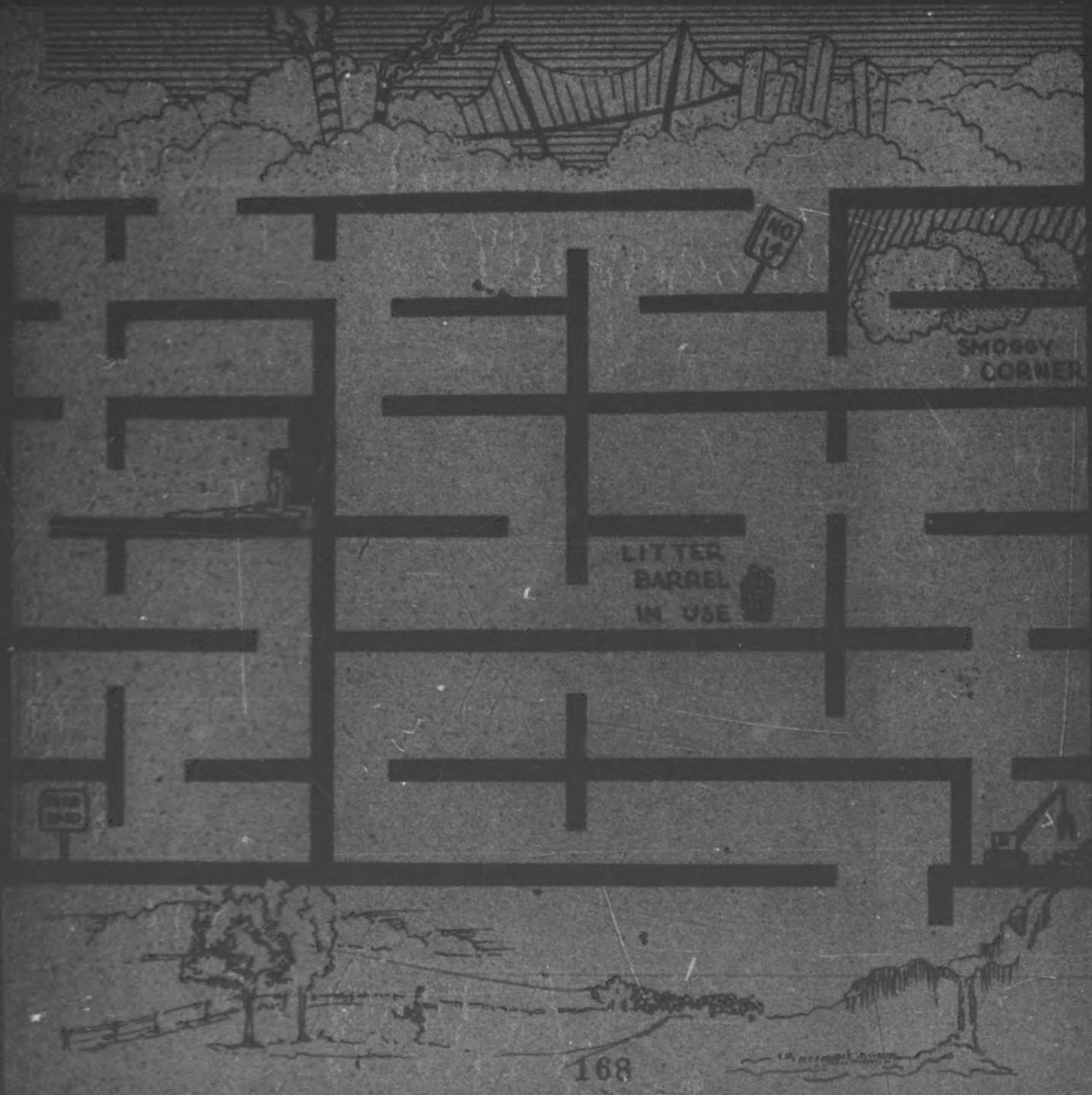
.. Organize a team of classmates and measure particulate levels in the area of your school. Identify the polluters. See if you can do anything to stop them from polluting your air.

.. Make a collage showing air pollution in different areas. Show the effects of air pollution on different areas.

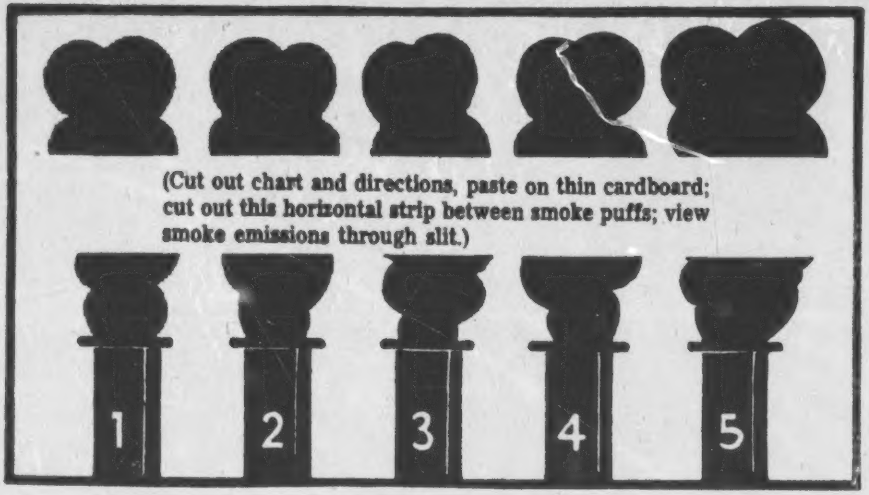
.. Find out the laws in your area regarding air pollution. Is open burning banned? What are acceptable levels of air pollution? Are acceptable levels the safest for human health?

what did you discover?

Use a map of the area showing the places which had the highest number of particles. Post it on the board. Plot the data from all students.


NO U
SMOGGY CORNER
LITTER BARREL IN USE

RINGELMANN CHART



(Cut out chart and directions, paste on thin cardboard; cut out this horizontal strip between smoke puffs; view smoke emissions through slit.)

NUMBER OF OBSERVATIONS	(TIME) INTERVAL	RINGELMANN'S NUMBER	TOTAL
1.			
2.			
3.			
4.			
5.			

TOTAL PRODUCT = ____________

6. Multiply number of observations by the chart number. Total the products and divide by the number of observations. This will give you the smoke density.

$$\frac{\text{TOTAL PRODUCT}}{\text{TOTAL OBSERVATION}} = \frac{\text{SMOKE}}{\text{DENSITY}}$$

Example:

Ringelmann No.		Observations	Total
1	X	5	5
2	X	7	14
3	X	8	24
4	X	10	40
		30	83

83/30 = 2.7 ≃ 3 (smoke density)

the problem:

The automobile presently accounts for 51% of the pollutants in the air. What can be done to reduce the amount of pollution from the automobile?

clues for you:

Keep a record of how much gasoline your family uses in one week. Multiply this figure by 52 to find out how much you use in a year. (Or, if your family has last year's records on how much gas they used, use this figure.) Every 1000 gallons of gasoline burned in a car produces 200 pounds of hydrocarbons. How many pounds of hydrocarbon does your family add to the air in a year?

Cars cause 51% of the air pollution in the United States and gasoline is running short. With the help of your classmates make a list of ways to reduce the amount of gasoline used in your families. Ask your parents to help conserve gas by using your list.

Materials:
Information card, Alternatives to the Internal Combustion Engine (42-1)

other ways to look at it:

.. What standards must auto makers meet by 1975? Research ways auto makers are trying to reduce air pollution. List the pollution control equipment being used on present cars.

.. Some scientists feel we must use other engines in our automobile. Read the information card, Alternatives to the Internal Combustion Engine. List the advantages and disadvantages of each type of engine.

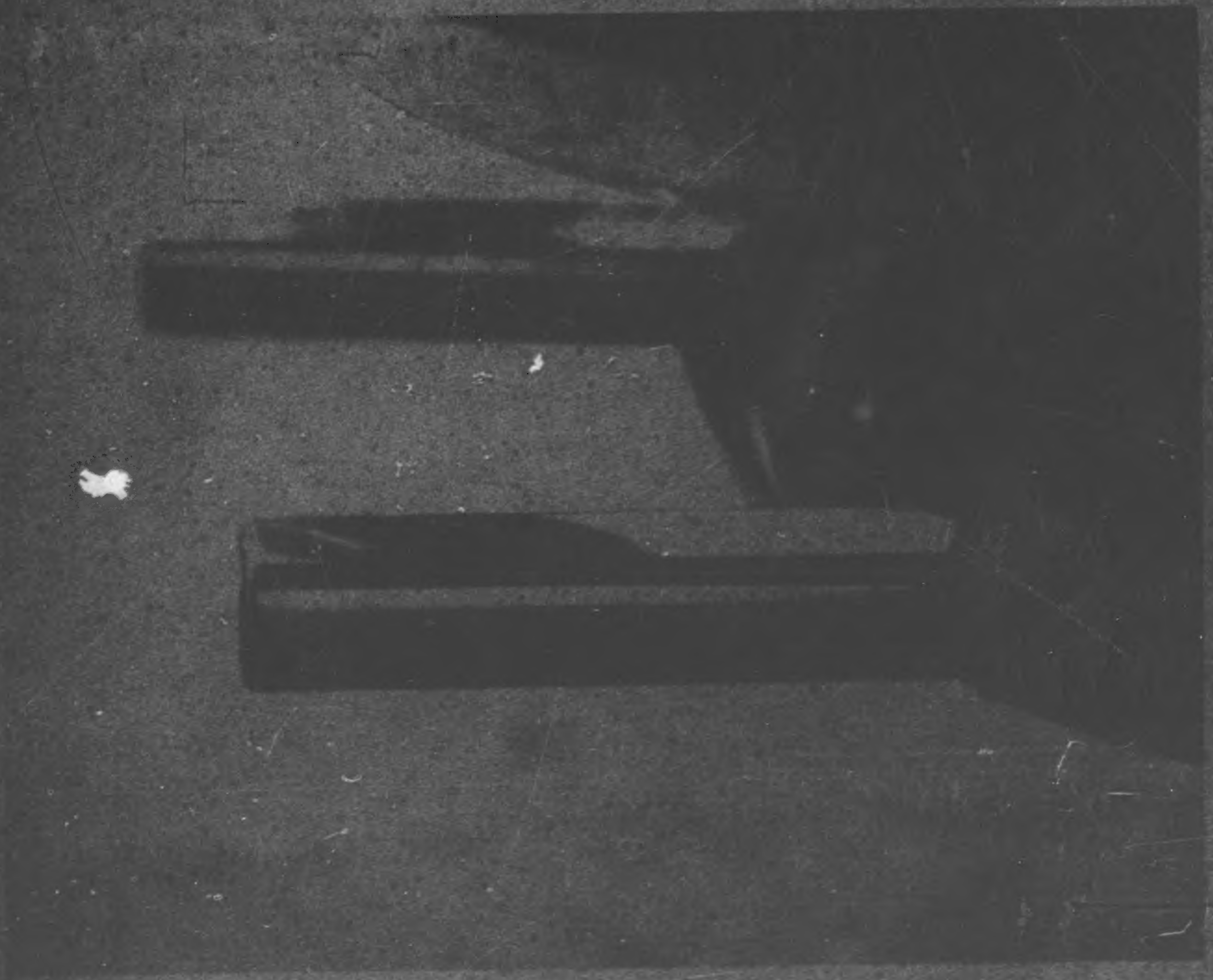
.. Visit a car dealer who sells rotary or CVCC engines. Have him explain the operation of these engines. How can they help reduce pollution?

.. Bring in models of the different kinds of engines. Explain their operation to the class. List their advantages and disadvantages.

.. Invite a mechanic to talk to your class. Ask him what your family can do to make sure your car runs well.

what did you discover?

Make a list of things being done to reduce automobile emissions.



INFORMATION CARD

Alternatives to the Internal Combustion Engine

In 1970, Senator Edmund Muskie (D-Maine) sponsored what is known as the Clean Air Act. The measure calls for a 90% reduction in harmful exhaust emissions by 1976 from what the cars put out in 1970. The act not only sets a deadline. It calls for a year-by-year reduction in emissions.

Present V-8 Engine with Catalytic Converter

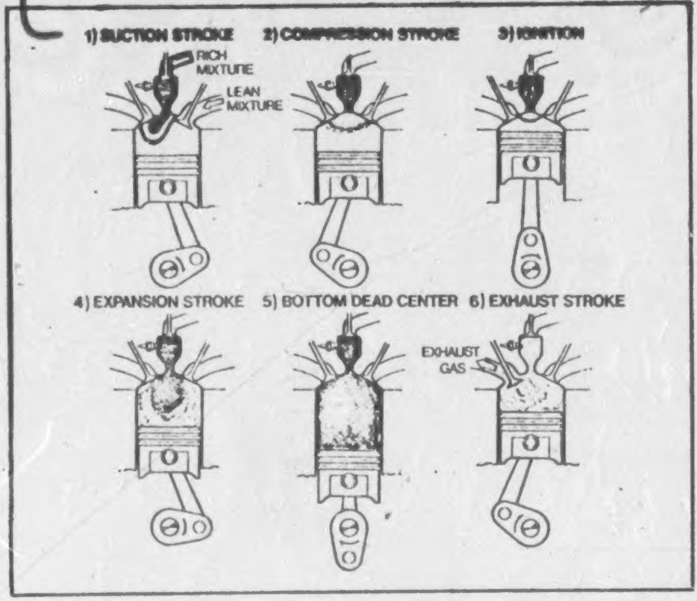
The present V-8 ENGINES are equipped with catalytic converters (sometimes called reactors) to help autos meet emissions standards. A catalytic converter works like an "afterburner." It oxidizes harmful exhaust hydrocarbons (HC) and carbon monoxide (CO). It burns them into harmless water vapor (H_2O) and carbon dioxide (CO_2). The catalytic converter is expensive and has a limited life. It must be replaced after about 25,000 miles.

CVCC Engine

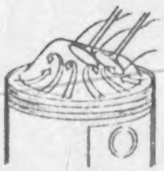
The Honda CVCC ENGINE is a low-emission engine. The CVCC engine is almost identical to the engine under the hood of your family car, with a small addition (see drawing). This drawing shows how Honda CVCC system works. A large amount of very low fuel mixture and a small amount of rich mixture enter through two intake valves (figure 1). At the end of the compression stroke (figure 3), the rich mixture near the spark plug is ignited. This in turn ignites the rest of the mixture (figure 4).

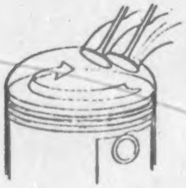
Honda tried to figure out how to make the fuel mixture so lean there would be almost complete burning. Honda created additional combustion chambers (mini-chambers). In these, a rich fuel mixture starts. Burning spreads from there to the main cylinder.

The fuel in the main combustion chamber is swirled or mixed. As a result, when the burning from the "mini-chamber" reaches the main chamber, there is more complete burning overall.


1) SUCTION STROKE
2) COMPRESSION STROKE
3) IGNITION
RICH MIXTURE
LEAN MIXTURE
4) EXPANSION STROKE
5) BOTTOM DEAD CENTER
6) EXHAUST STROKE
EXHAUST GAS

Drawings show the relatively gentle swirl given to the mixture in the Honda CVCC engine.

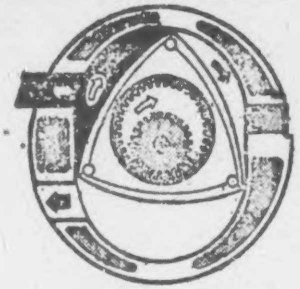

CONVENTIONAL ENGINE


CVCC ENGINE

Rotary Engine

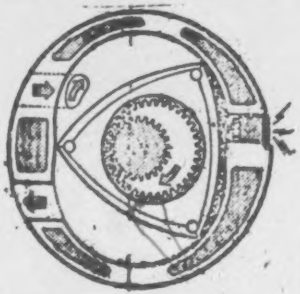
Mazda's Wankel ROTARY ENGINE is also giving Detroit auto-producers a run for their money. Mazda's rotary is based upon the design of German engineer, Felix Wankel. The Mazda company heard about the engine during the 1950's. It sent a crew of engineers over to Germany to look at it. They came back to Japan with a license to produce them. Since then, Mazda has produced over 400,000 rotary cars. It has sold them in more than 80 countries, including over 20,000 in the United States.

The rotary engine is quite simple. Two rotors twirl lazily around a central shaft. They are the only basic moving parts in the entire engine. The engine does away with cams, valves or lifters. The rotors themselves open and close the intake and exhaust ports. There is less to go wrong and less to repair (see drawings).



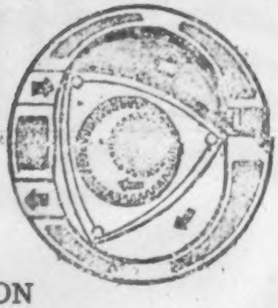
INTAKE

As the piston at right starts downward in the cylinder, it opens a valve at the top. This draws in a gas-air mixture. This "charge" flows into the chamber and the triangular rotor sweeps past an intake port (white arrow) in the wall.

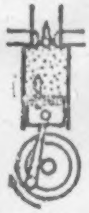


IGNITION

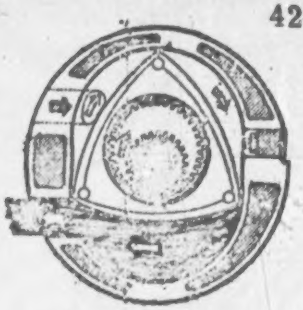
As the rotor face moves down the comparatively flat side wall, the gas is ignited and expanded. This provides the thrust to keep the rotor turning. At right, ignition propels the piston on its downward "power stroke."



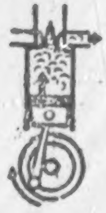
COMPRESSION



As the Wankel rotor turns, the gas (in dark gray area) is pushed toward the spark plug. A second point of the triangle trails across the intake port and covers it momentarily. At right, the valve shuts as the piston starts upward, beginning to compress the fuel mix.



EXHAUST



The rotor cleans house. It sweeps the waste products of combustion out an exhaust port (white arrow). While this completes the final phase, new cycles have already begun. This is a continuous process. In the conventional piston engine, the exhaust goes out through a second valve as the piston thrusts up for the last time.

The secret of Mazda's emissions control is the thermal reactor. It is molded into the exhaust manifold. This reactor does the same thing as the catalytic converter, with one major exception. The thermal reactor is a simple type of hollow exhaust manifold. The catalytic converter is lined with a catalyst to promote oxidation. When the catalyst in the catalytic reactor goes dead (which it can at any time), the owner must replace it. The Mazda's thermal reactor has nothing to go dead.

In an EPA report on the Mazda made March 1, 1973, the engine was also praised for its day-to-day operation.

Electric Car

Some people favor the development of an ELECTRIC CAR as a means of reducing emissions. They claim it is: (1) silent, (2) exhaust free, (3) powered by a simple motor which is 90% efficient, (4) easy to handle, and (5) inexpensive to maintain. However, the original cost of an electric car would be very high. In fact, it would probably have to be rented if most people were to afford it.

As many as 16 expensive, low-energy-density batteries are needed to make the car go. Together they weigh the car down. They take up as much space as the entire trunk area. No existing electric car can cruise much further than 80 miles or longer than a few hours. Then they stop for a lengthy recharging. The additional generation of electrical power to recharge the batteries might cause as much pollution as the internal combustion cars. If clean electric power sources are developed, an attempt to develop more practical electric cars might be worthwhile. Electric car manufacturers are trying to develop better batteries while they are producing smaller vehicles for local use such as golf carts, lift trucks and postal delivery vans.

The best way to protect the environment against emissions from motor vehicles might be to use a variety of new engines. Each will be best suited to the purpose of the car. However, both the automobile industry and the petroleum industry could be expected to provide strong opposition to the development of new vehicles which would cut into their profits. The government could encourage the development of cleaner engines. They could offer large contracts for government vehicles to the company which can produce the most efficient, cleanest engine.

Ludvigsen, Karl. "1976 Vega-Honda." Science and Mechanics, July 1973, pp. 40+.

Teacher's Environmental Resource Unit: The Automobile. Compiled by Brevard County Center for Environmental Learning, 1972, pp. 39-45.

Wyss, Wally. "Can America Afford to be Last?" Environmental Quality, June 1973, pp. 44-46.

Questions for Thought

1. What emissions can be controlled by a catalytic converter?
2. What disadvantage is associated with the catalytic converter?
3. How, basically, does the Honda CVCC differ from the conventional ICE? How does this help control emissions?
4. Are CVCC engines durrently available in this country?
5. What are the major advantages of the Mazda's rotary engine?
6. List advantages and disadvantages of the electric car.
7. Should the federal government make a decision to "funnel" all available funds into the development of ONE of the above types of engines?

VOCABULARY

1. alternatives: another possible choice; option
2. combustion: the process of burning
3. sponsored: supported, introduced
4. emissions: substances which are emitted (given off)
5. converters: changer
6. oxidizes: combines with oxygen
7. ignite: to start burning
8. chambers: compartments, sections
9. rotary: going in a circular pattern
10. catalyst: a substance which speeds up a chemical reaction between other substances
11. promote: increase
12. generation: production, making of something (as of electric power)

the problem:

How does the need for transportation affect the environment?

clues for you:

List all the possible methods of transportation in your area. As a class, make a map of the area around your school showing:

- a. bike paths
- b. road ways
- c. mass transit (buses, trains)
- d. sidewalks
- e. parking lots

List in order from largest to smallest, which of the above takes up the most land.

Using the data card, compile a list of the ways each method of transportation listed affects the environment. For example, does walking have any effect on air pollution? Water pollution? Does driving a car have any effect on air pollution?

Materials: map of community, notebook information card, Land Use (43-2) data card, Transportation (43-1) graph, Decline in Use of Mass Transit in U. S. (43-3)

other ways to look at it:

.. Study the graph, Decline in Use of Mass Transit in the U. S. When did the most people use mass transit? Why do you think this happened? What things led to a decline in the use of mass transit in the United States? Do you think mass transit will become popular again now that gas prices have risen?

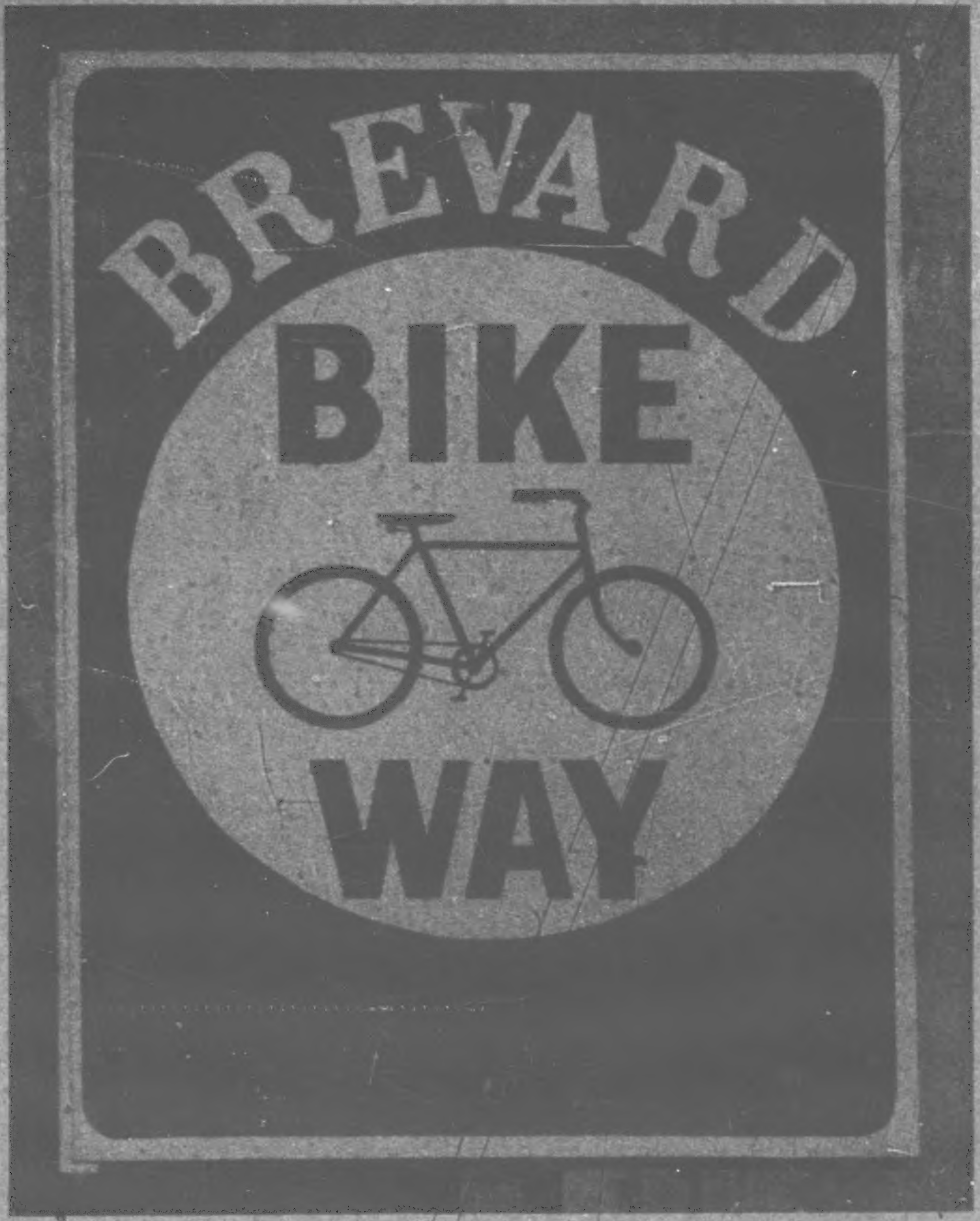
.. Is any form of mass transit available in your community? How many people use it each week? Month?

.. Would people in your area use mass transit? Which type would they favor? Conduct a survey to find out.

.. Do you have enough bike paths and sidewalks in your area? Take a survey and find out. Are they clearly marked as bike paths? Find out if the local city or county government has any plans for making more bike paths available. Debate the pros and cons of a bike path in your area.

what did you discover?

List all the methods of transportation people use, and the way each affects the environment.


BREVARD
BIKE
WAY

DATA CARD ON TRANSPORTATION

Type of Transportation	Way It Affects The Environment					Is it Available in Your Community?
	Air	Water	Land	Noise	Litter	
Walking						
Bicycle						
Automobile						
Bus						
Plane						
Train						
Monorail						

INFORMATION CARD

Land Use

The following table compares the amount of land each type of transportation requires. Use this information in comparing types of transportation.

Auto: A transportation corridor one highway lane (12 feet) wide can carry a maximum of 3,600 passengers per hour.

Bus: Half-filled buses can carry 60,000 people per hour - seventeen times as many as the car.

Train: Trains, half-filled, will transport 42,000 passengers per hour - twelve times the number handled by the auto.

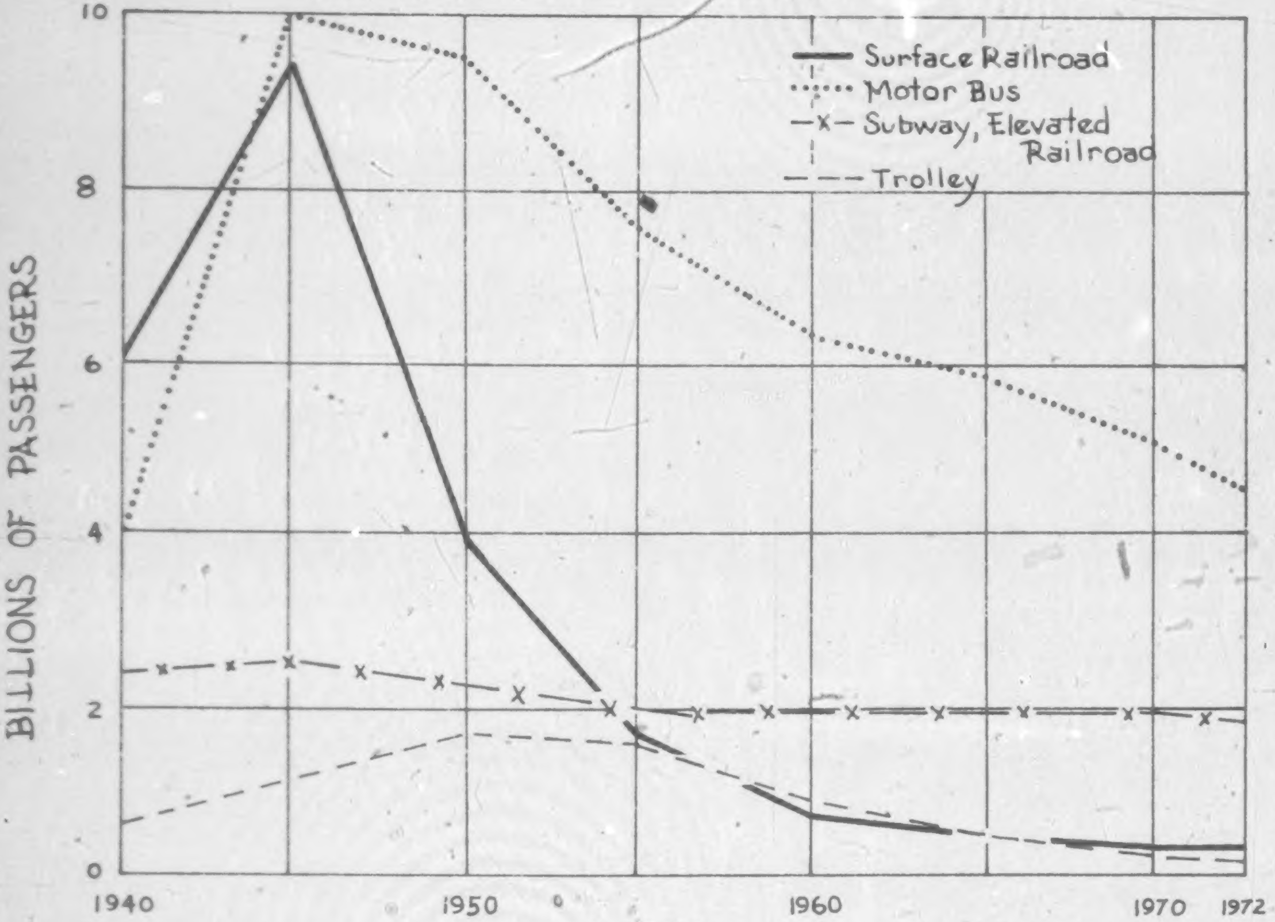
Bicycle: A highway lane can comfortably hold two bicycle lanes, allowing passage of 10,600 people per hour - almost three times as many as cars.

Walking: A path the width of a highway lane can accommodate 6,300 walkers per hour - almost twice as many as automobile passengers.*

6

SOURCE: Kenneth P. Cantor, "Warning: The Automobile is Dangerous," The Environmental Handbook, ed. Garrett De Bell, New York, Ballentine Books, Inc., 1970, p. 200.

Decline in Use of Mass Transit in U.S.



Source: AMERICAN TRANSIT ASSOCIATION, '72-'73 *Transit Fact Book* (1973

Study Guide for
Decline in Use of Mass Transit in U. S.

1. When was mass transit the most popular in the U. S. ?

2. How many billion passengers were transported in 1945?
   How many were transported by surface railroad?

3. How many billion passengers were transported in 1970?

4. Is the number of passengers using mass transit increasing or decreasing?
   Why do you think this is happening?

5. What is presently the most popular form of mass transit?
   How do you account for this?

6. Which form of mass transit is the least popular?
   Why do you think this is so?

7. Which forms of mass transit have you used?
   Which forms are available in your community?

the problem:

Can you express your feelings about nature?

clues for you:

Try a cinquain. It is a special form of poetry. The formula is given below:

The 1st line has one word—the subject;
The 2nd line has two words—words that describe;
The 3rd line has three words—action words;
The 4th line has four words—your feelings about the subject;
The 5th line is only one word—the summary.

Make a water color on the same subject as your cinquain. Share it with the class.

Materials:
information card, Writing Haiku Poetry (44-1)

water colors	water color paper
art materials	magazines
scissors	brushes

other ways to look at it:

.. Select a song or peom about beauty or nature (like America the Beautiful). Contrast the words to what you really see happening to the environment. Find pictures from magazines. Organize a bulletin board display using this idea.

.. Try other forms of poetry. Haiku is a Japanese poetry form used to express one's feelings about nature. Read the information card, Writing Haiku Poetry. Play a Haiku game with a friend.

.. Collect pictures to go with your poems. Make a book of poetry and pictures.

.. Use art to express your feelings about the environment. Use sketches, photographs, collages, rubbings, mobiles, or anything else you like.

.. Plan a program about the environment. Invite your parents.

what did you discover?

Share with the class at least one way you expressed your feelings about the environment.

BANK
Brevard
BANK
CORPORATION
Sears SERVICE

Go, stop, turn

Most people have cars.

Transportation

INFORMATION CARD

How to Write Haiku Poetry

One of the most popular forms of poetry in Japan for many years has been Haiku. The first known Haiku poem was written in the 13th Century, over 700 years ago. It is a very personal form of poetry. The writer of Haiku writes it only for a friend to read, and not to be published. The friend usually writes one back. Its popularity spans all ages and all ranks. The emperor in his palace, the bus driver on his break, the farmer in his field and the schoolboy during lunch have been known to play the Haiku game.

Another reason for the popularity of Haiku is that it follows so much the Japanese way of life. One must be very observant, have a sincere love of nature, and have the ability to think about things indirectly.

Even though the following rules are simple to follow, it is not necessary to follow them all the time. Even the Japanese don't, if sticking to the rules stunts the effectiveness of the poem. The main goal of the Haiku is to have the reader "see" the picture the writer describes and feel his emotion at the sight. Ideally, the reader not only experiences the writer's emotions, but reading the Haiku enables him to experience his own. Of course, reading and writing Haiku makes a person more observant and aware.

(elements)

Simple rules for writing Haiku:
- three lines
- Line 1 5 syllables long
- Line 2 7 syllables long
- Line 3 5 syllables long
- refers to nature
- mentions the season (directly or indirectly)

Additional rules:
- it is about one event
- the reader fills in the details
- it refers to one or more of the five senses
- it is usually written in the present (as it if is happening right now)
- it is about one moment of awareness involving deep feeling

Sample Haiku:

Old dark, sleepy pool
Quick unexpected frog
Goes plop! Water splash!

Flowers here and there
They are sprouting all around
Making the world smile

Autumn leaves are down
Colores are red and yellow
Making the ground light

The deer stops and looks
At the white wonderful world
All around himself

A still, dark figure
It stirs, leaps onto my bed
It's a purring cat

Lofty, white glaciers
They are looking down at me
Very close to God

Trees grow all around
Becoming old and stately
Watching the world grow

Butterflies flying
All stopping at bright flowers
Red, black, orange

Snow is sparkling
Falling lightly down to Earth
White, graceful, lace snow

(Note: All the above Haiku were written by elementary school students except the first one. It was written by one of the most famous Haiku writers, Basho, over 300 years ago.)

Writing Haiku and Other Short Forms of Poetry. William Browne and Adele Harris, Educational Activities, Inc., Freeport, N. Y., 1970.

the problem:

Twenty-five percent of the electrical output of power companies is used by homes. In Florida, between 1960 and 1970, the average family use of electricity more than doubled. (Use rose from 393 to 883 kilowatt-hours per month.) Do you contribute to this problem?

clues for you:

Electrical use is measured in kilowatt-hours. Take your family's electric bills for three months. Find the number of kilowatt-hours (KWH) on each bill. If you need help, read the card, Understanding Your Electric Bill. Add the KWH for the three bills. Divide this number by three. This will give you an average. How much electricity does your family average each month?

Start a family project. Try to reduce the amount of electricity you use. You will find some suggestions on the card, Saving Electricity. Compare your bills after several months. Do you see any difference?

Why should you be concerned about the amount of electricity you use?

Materials:

electric bills for three months
information cards, Saving Electricity (45-1) and Understanding Your Electric Bill (45-3)

other ways to look at it:

.. Part of your electricity is for lights. Survey your home. List ways to reduce the amount of electricity used for lighting. Try to get your family to cooperate with your suggestions. Report on your results.

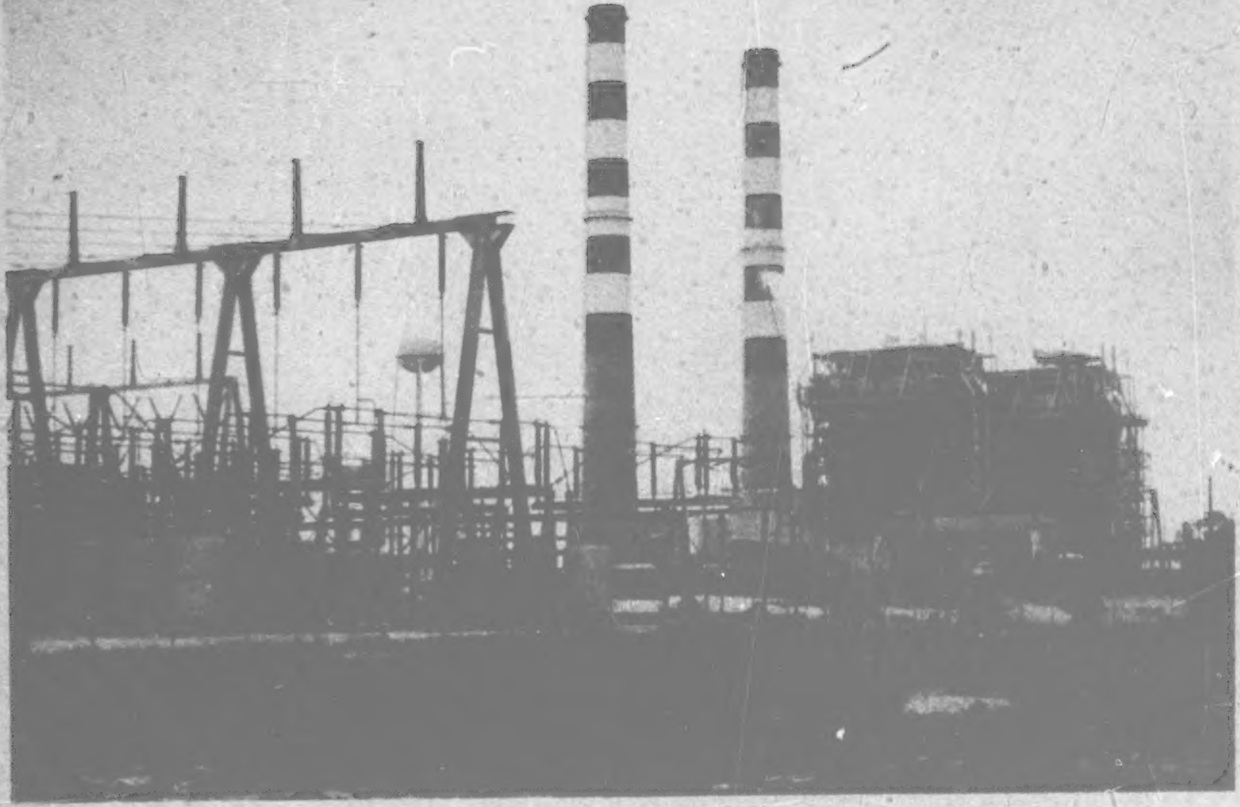
.. Most homes have about 30 electrical appliances. Survey your home. List all the electrical appliances. Star the ones you could do without. Try it. Suggest ways to cut down the use of other ones. Try it. Report your results.

.. Electricity can be produced many ways. How is it produced in your area? How else can it be produced? What is the cheapest way to produce electricity? What is the cleanest way? How does the production of electricity affect the environment?

.. Suggest ways your school could save electricity. Ask your principal to review your list and comment on it. Can any of the ideas be tested?

what did you discover?

Report to the class on three ways you used to reduce the use of electricity in your home. Show how effective these methods were.



SAVING ELECTRICITY[1]

How to Save on the Use of Lights

1. Do not leave lights burning when they are not needed.
2. Open drapes and blinds and use non-polluting sunlight.
3. When choosing colors for your room, remember that light colors reflect more light than dark ones.
4. Try replacing high wattage bulbs with bulbs of lower wattage (see chart).
5. When you add light fixtures to your house, think about fluorescent lights. They produce more light per watt, are less expensive to use, give off less heat, and last up to ten times as long as incandescents.

What Does It Cost to Use Lights?

25 watts - 100 hours - 6¢
40 watts - 100 hours - 9¢
60 watts - 100 hours - 14¢
100 watts - 100 hours - 23¢

How to Save on the Use of Appliances

On the back of this card, there is a chart giving the approximate cost for operating most electrical appliances. Below are given some suggestions for reducing the amount of electricity you use for appliances. Some of the suggestions are really for your parents. Take this list home and discuss this with them. Saving electricity also saves money -- in more ways than one!

1. Ask yourself if you really need to use that appliance.
2. Air conditioners use lots of electricity -- try to set the thermostat higher; a few degrees can make a lot of difference. In the spring and summer, try using fresh air -- we may not have it forever.
3. Use dishwashers and washers only when you have a full load. This saves water too.
4. Try setting the thermostat on your hot water heater lower. Most of the time you end up cooling the hot water. If hotter water is needed for laundry, set the thermostat up a few hours before you start.
5. Don't overdry clothes.
6. Turn the TV and radio off when not in use.
7. Close the refrigerator door; don't open it unless it is necessary.

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[1] Koestner and others, The Do-It Yourself Environmental Handbook, Boston: Little, Brown and Company, 1972.

Cost of Appliances[1]

Appliance	Average Wattage	Estimated Use Per Day	Annual KWH Consumed	Average Monthly Cost
Heat Pump (Combined Air Conditioner and Heater)	11,848	3.7 hr.	16,003	15.00
Water Heater (Quick Recovery)	4,474	2.9 hr.	4,811	5.50
Water Heater (Standard)	2,474	4.7 hr.	4,219	4.80
Refrigerator-Freezer (Frostless — 14 cu. ft.)	615	8.2 hr.	1,829	3.40
Food Freezer — Frostless (15 cu. ft.)	440	11 hr.	1,761	3.23
Air Conditioner	1,566	2.4 hr.	1,389	2.40
Refrigerator-Freezer	321	10.3 hr.	1,217	2.31
Food Freezer (15 cu. ft.)	341	9.6 hr.	1,195	2.15
Range	12,207	16 min.	1,175	2.22
Refrigerator-Freezer (14 cu. ft.)	326	9.6 hr.	1,137	2.08
Clothes Dryer	4,856	34 min.	993	1.85
Refrigerator (12 cu. ft.)	241	8.2 hr.	728	1.29
Television (Color)	332	4.1 hr.	502	.86
Dehumidifier	257	9.6 hr.	377	1.61
Dishwasher	1,201	50 min.	363	.69
Television (Black and White)	237	4.2 hr.	362	.66
Fan (Attic)	370	2.2 hr.	291	1.31
Roaster	1,333	25 min.	205	.41
Frying Pan	1,196	26 min.	186	.36
Radiant Heater	1,322	22 min.	176	.58
Humidifier	117	3.8 hr.	163	.49
Bed Covering	177	2.3 hr.	147	.48
Iron	1,008	23 min.	144	.29
Roll-about Fan	171	2.2 hr.	138	.60
Coffee Maker	894	20 min.	106	.19
Washing Machine	512	33 min.	103	.20
Broiler	1,436	11.3 min.	100	.21
Hot Plate	1,257	12 min.	90	.19
Radio	71	3.3 hr.	86	.17
Deep Fat Fryer	1,448	9 min.	83	.16
Washing Machine (Nonautomatic)	286	44 min.	76	.15
Vacuum Cleaner	630	10.8 min.	46	.09
Toaster	1,146	5.6 min.	39	.08
Food Disposer	445	11 min.	30	.05
Waffle Iron	1,116	2.4 min.	22	.04
Shaver*	14	210 min.	18	.04
Clock	2	24 hr	17	.04
Sun Lamp	270	9 min.	16	.04
Food Blender	386	6 min.	15	.04
Hair Dryer	381	6 min.	14	.04
Food Mixer	127	17 min.	13	.04
Sewing Machine	75	24 min.	11	.04
Carving Knife	92	12 min.	8	.02
Toothbrush*	7	117 min.	5	.01

*Cordless units which are plugged in for recharging as needed during non-use periods

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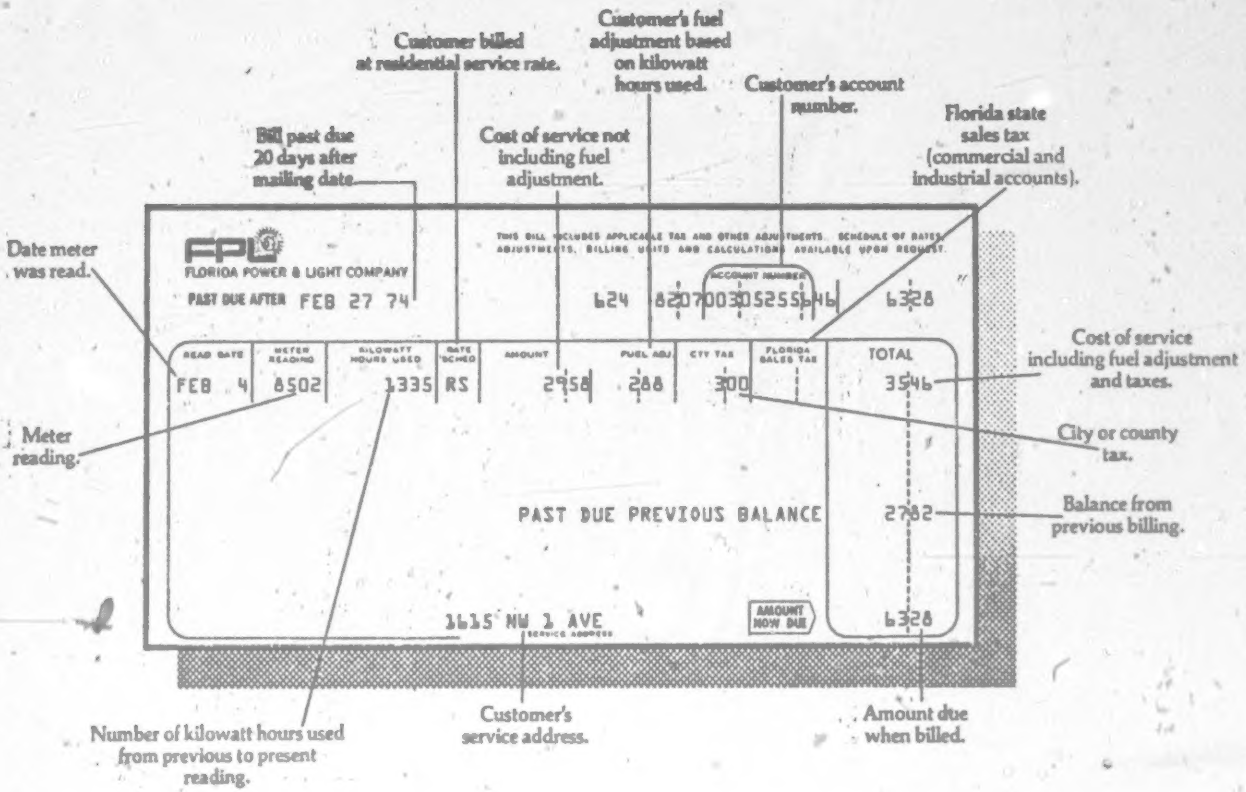
[1] Koestner and others, The Do-It Yourself Environmental Handbook, Boston: Little, Brown and Company, 1972.

How to understand your electric bill.



FPL
FLORIDA POWER & LIGHT COMPANY
PAST DUE AFTER FEB 27 74

THIS BILL INCLUDES APPLICABLE TAX AND OTHER ADJUSTMENTS. SCHEDULE OF RATES, ADJUSTMENTS, BILLING UNITS AND CALCULATIONS AVAILABLE UPON REQUEST.

624 82070030525546 6328

ACCOUNT NUMBER

READ DATE	METER READING	KILOWATT HOURS USED	RATE SCHED	AMOUNT	FUEL ADJ	CTY TAX	FLORIDA SALES TAX	TOTAL
FEB 4	8502	1335	RS	2958	288	300		3546

PAST DUE PREVIOUS BALANCE 2782

1615 NW 1 AVE
SERVICE ADDRESS

AMOUNT NOW DUE 6328

Customer billed at residential service rate.

Customer's fuel adjustment based on kilowatt hours used.

Customer's account number.

Bill past due 20 days after mailing date.

Cost of service not including fuel adjustment.

Florida state sales tax (commercial and industrial accounts).

Date meter was read.

Cost of service including fuel adjustment and taxes.

Meter reading.

City or county tax.

Balance from previous billing.

Number of kilowatt hours used from previous to present reading.

Customer's service address.

Amount due when billed.

the problem:

Is there a solution to the "energy crisis"?

clues for you:

Within your group, assign parts for a hearing you will hold on energy. You will need someone to represent the energy producers, comsumers, environmentalists, government, and pollution control agency. Study the information cards on energy and any other information you can find. In a hearing before the class, discuss what things can be done to help ease the energy crisis. Can you come to any conclusions? What policies need to be started, changed, or done away with to help solve the shortage? Discuss new forms of energy that can be developed. How does each affect the environment?

Materials:
information card, Our Energy Crunch (46-1) accompanying charts, U.S. Consumption of Energy by Source (46-5) and The Oil Gap (46-4)

other ways to look at it:

. . Iceland and California have used geothermal energy for years. Find out how this is done.

. . Study the chart, Total U.S. Consumption of Energy by Source. What was the main source of energy in 1850? in 1900? in 1970? What has brought about these changes?

. . Dr. Farber at the University of Florida Solar Energy Lab has done a lot of research on using solar energy. Find out more about solar energy as a fuel.

. . Study the graph, The Oil Gap. What has happened to the production of oil each year? What has happened to the use of oil? What things can be done to reduce the need for oil?

. . Let your imagination go wild. Develop an ideal system for producing energy for use in the future.

. . Make a list of the things that cause energy shortages.

what did you discover?

After your hearing, write a short report giving your conclusions as to ways to solve present energy shortages.

OIL

Known U.S. oil reserves may run out within 15 years. New discoveries are slow. We are importing more and more foreign oil.

NUCLEAR

Promising but slow in developing. Nuclear power today contributes less than one per cent of U.S. energy. Atomic power plants must be carefully shielded. Disposal of wastes is a problem.

SOLAR

This area is promising, but far from use at this time. As yet, there's no practical way to store energy from the sun.

GAS

Our known gas reserves are running out fast. Within 15 years, demand may exceed existing domestic supply.

WIND

Windmills still work in some areas, but they're unreliable and inefficient.

COAL

There's enough U.S. coal to last an estimated 400 years. Based on BTU values, coal makes up 88 per cent of the nation's energy reserves. Greater utilization of coal held back by its harm to the environment.

WATER

Only about 4 per cent of the nation's energy comes from water power. And we've already harnessed our best sources.

GEO - THERMAL

Heat from the interior of the earth has been tapped in a small way at demonstration sites. This area needs more research.

46-1

INFORMATION CARD

Our Energy Crunch

Bundle up. Grab your wallets. Get ready for more big price increases for heat, lights, gasoline and everything that uses energy. Count on occasional fuel shortages, too. Don't expect things to stop getting worse before 1980, if then.

That's the general outlook for America's energy problems.

Now for the bad news.

The possible side effects of the energy mess are just as bad.

The possibilities include dirtier oceans, dirtier foul air, radiation poison, more stripmine gashes in the American landscape, even a world currency crisis.

How did the nation get into this mess?

Blame a laggard government that has ignored warnings for at least 20 years.

Blame the drive of major oil, gas, and coal companies for high profits and low taxes while demanding more economic incentives to produce more.

Blame nature for putting more cheap oil under Saudi Arabia than under the United States and Russia combined.

Blame the American consumer, who makes up 6 percent of the population but gobbles up 33 percent of the world's energy supplies. And he thirsts for more.

----Jackson, Brooks. (AP).
Today Newspaper.
March 6, 1973. p. 1A

Every year since 1947, Americans have increased their use of energy more than 3%. Unless we lower our standard of living or find more efficient ways to use energy, our present needs will double every fourteen years. Much of our energy needs are necessary for mass transportation, improving our cities, and meeting the needs of a growing population.

Because energy has been cheap, it has been used to power many unnecessary things. Most of us have electric toothbrushes, combs, can openers, and several TV sets. We live in homes that are air-conditioned and heated. We drive to work alone in an automobile. At night there are signs advertising businesses that are closed. We light our streets and our highways with extensive lighting systems. Restaurants are air-conditioned so cold that a sweater is necessary to be confortable. We refine new products instead of using ones already made. Goods are packaged in fancy wrappings that are discarded soon after the product is carried home.

According to the U.S. Geological Survey there is enough coal to last 200-500 years in this country alone. Some home owners have switched to gas or oil because they cause less air pollution. Many commercial companies have also switched to oil or gas. The electric companies are now using oil or gas for the production of electricity.

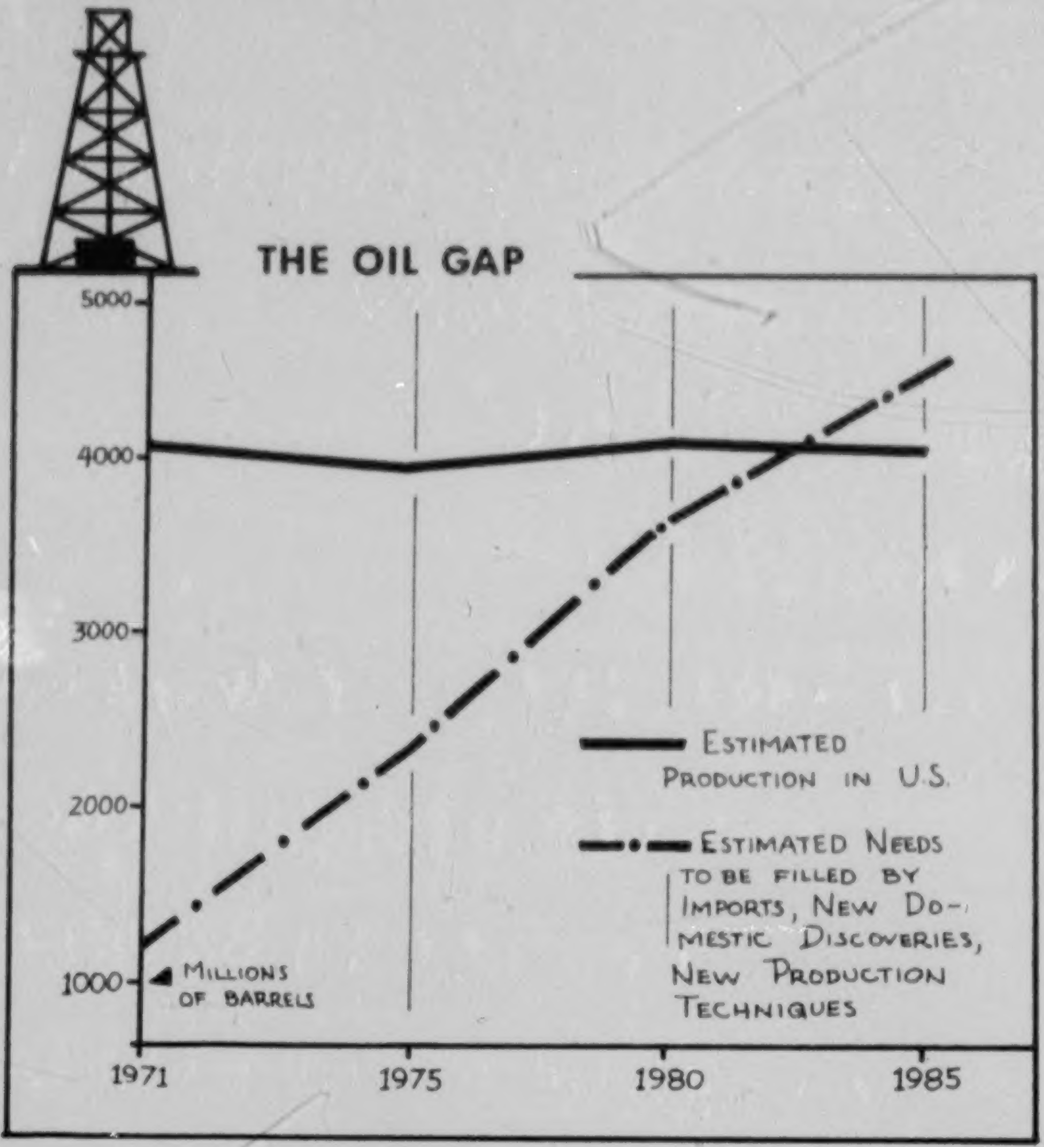
Natural gas played a key role in the energy crunch. Since 1968 this country has been using natural gas twice as fast as it has been found. The gas industry's experts tell us there is only an 11 year supply of gas left in known reserves. The industry wants to raise prices and use the money to explore for future needs.

Experts also estimate that the oil resources in America will be used up in another 30 years. The anti-pollution forces are blocking exploration of oil resources in some areas.

As early as 1952, the government set up agencies to help solve the use of our energy supplies. There are 65 agencies trying to form a national policy on energy. In the summer of 1972, American refineries ran at full capacity turning out gasoline. As winter approached fuel oil for heating became scarce. Shortages developed in some areas. The refineries reversed themselves and began producing more fuel oil. Immediately gasoline became scarce and gas stations closed or rationed their supplies to only ten gallons per customer. Long lines developed at gas stations and some states set up certain days for certain cars to get gasoline.

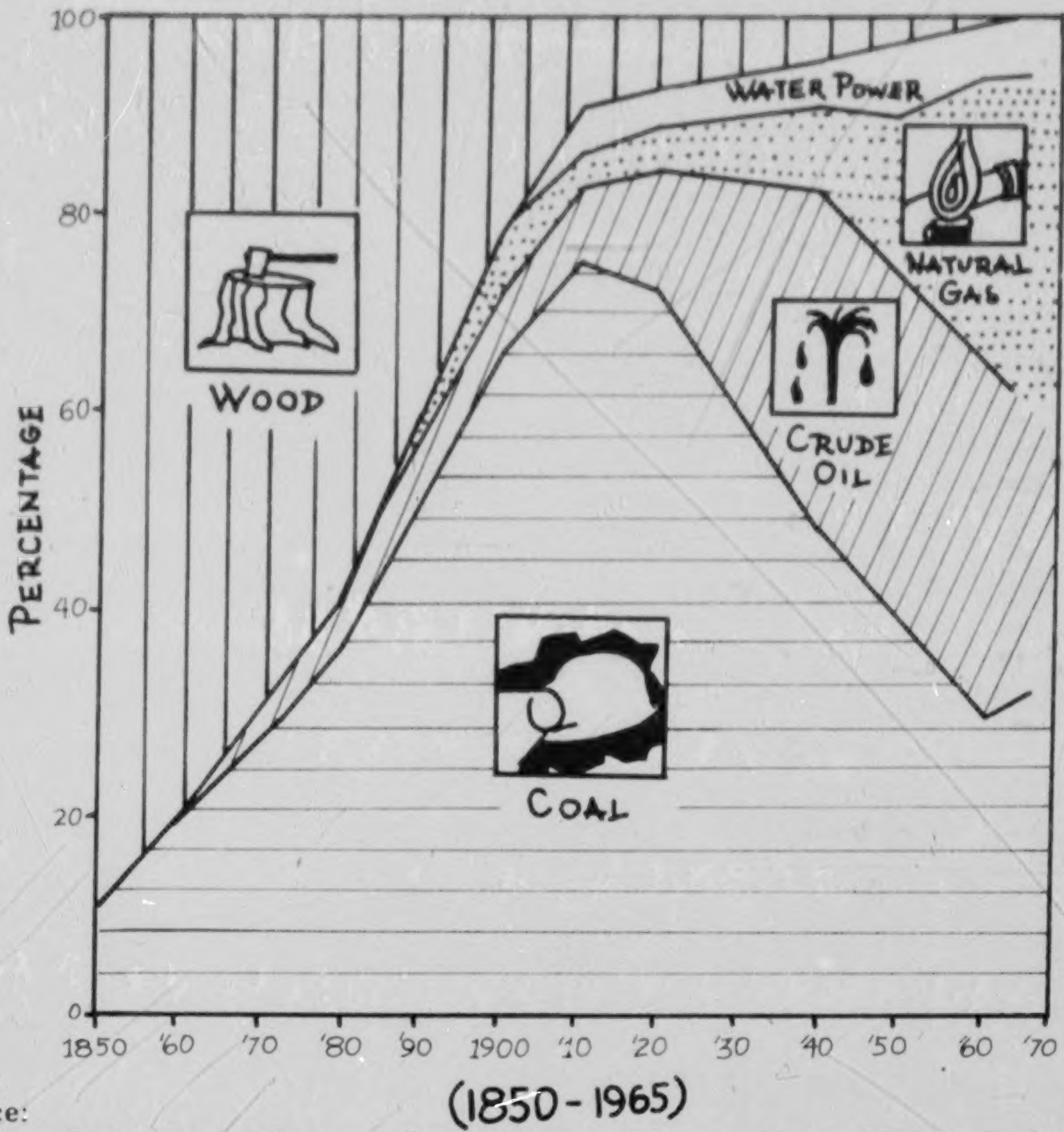
Oil is now being imported at rates higher than ever before. We need new refineries to change the crude oil into usable products. Foreign countries have raised the price of crude oil. All of these factors have contributed to the problems of where and how do we get cheap energy.

Two alternatives to the problem are coal and nuclear power. Our coal supplies are not being used at a rapid rate because of air pollution caused by the burning of coal. Research is now being conducted to find a way to burn coal and prevent air pollution. Nuclear power plants are also being built to provide electricity. These are also being researched to be sure there is no hazard to wildlife and to humans. At the end of 1973 there were 29 nuclear power plants in operation, 57 in stages of construction and 76 in the planning stage.



Source:
Today, "Energy Pinch? Consumer Pays", Howard Benedict (AP), March 7, 1973.

Total U.S. Consumption of Energy by Source



Source:
Teachers Environmental Resource Unit: Energy and Power, Brevard County Center for Environmental Learning, 1972.

the problem:

S-47

Does noise effect simple learning?

One form of simple learning is running a maze. Your teacher has a copy of a maze you may use for your experiment.

clues for you:

Divide the students into two groups. Each student will do the maze three times. Record their time for each trial. The two groups will try the mazes under different conditions. The control group will work under quiet conditions. The experimental group will be interrupted by loud noises. The best way to do this is by using earphones and cassette tapes with loud noises on them.

Find the average time for each group on each trail. Add the times for each student in the group on that trial. Divide the total by the number of students in the group. This is the average. Do this for each trial.

Make a graph comparing time for each group on each trial.

Materials:
3 copies of maze per student (47-2)
1 copy of blank graph (47-1)
cassette recorder, earphones

Materials: (cont'd)
watch or timer
information cards, Noise is an Invisible Pollutio
(47-3) and Noise (47-4)

other ways to look at it:

.. Did the noise affect the time it took to run the maze? Try the experiment again and switch groups. Are the times the same? Try playing soft music. What happens to the time?

.. Read the information card, Noise. Do you know people who add noise makers to their cars? bicycles? How does noise affect living things?

.. How is noise measured?

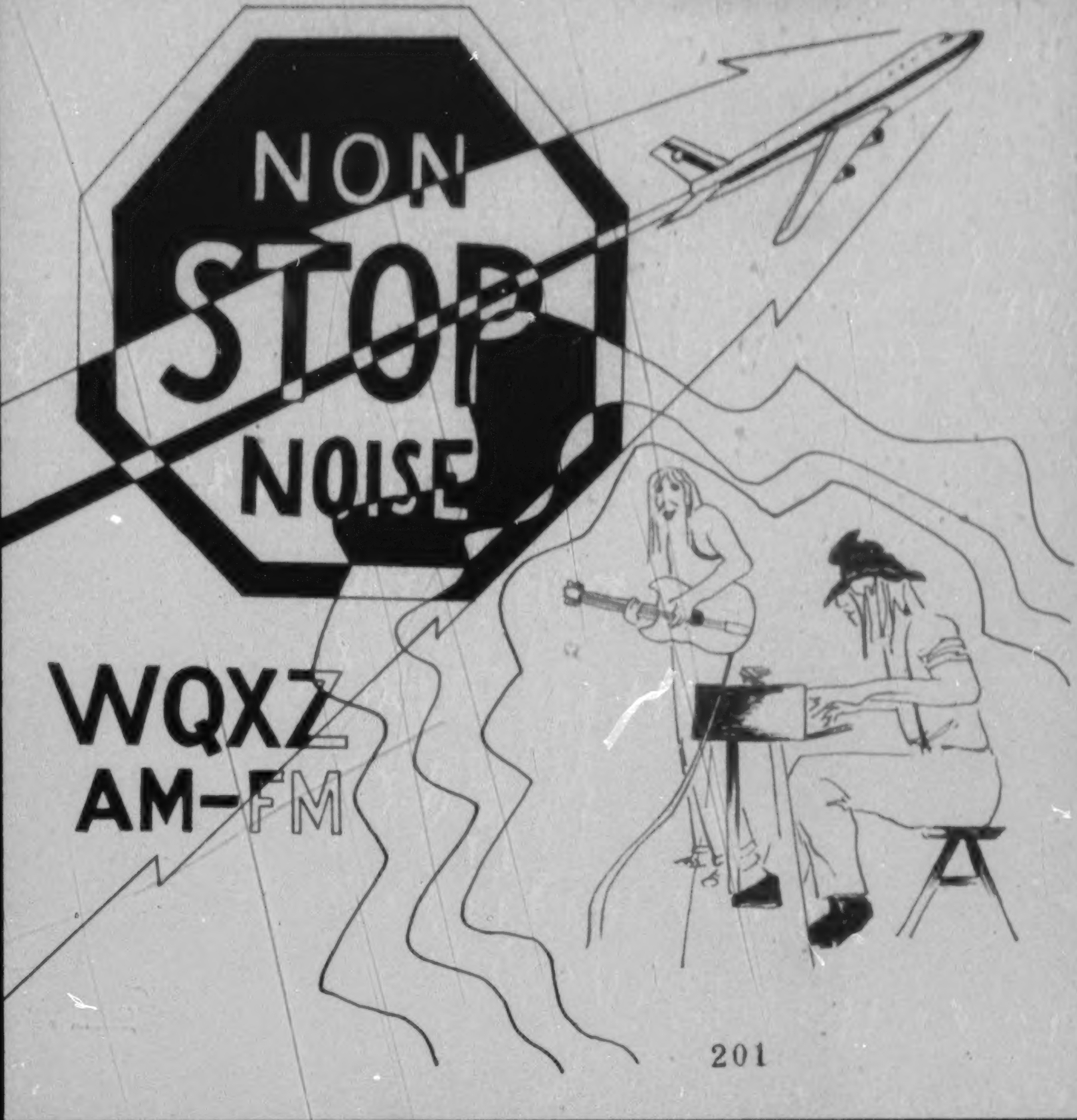
.. How may noise affect simple daily activities? - driving a car, eating, sleeping, playing a game, homework?

.. Read the information card, Noise is an Invisible Pollution. What is the federal government doing to combat noise pollution?

.. Make a list of jobs in your community where the noise level is high. Is anything done to protect people on these jobs?

what did you discover?

. Post your completed graph and the conclusions you reached.


NON STOP NOISE
WQXZ
AM-FM

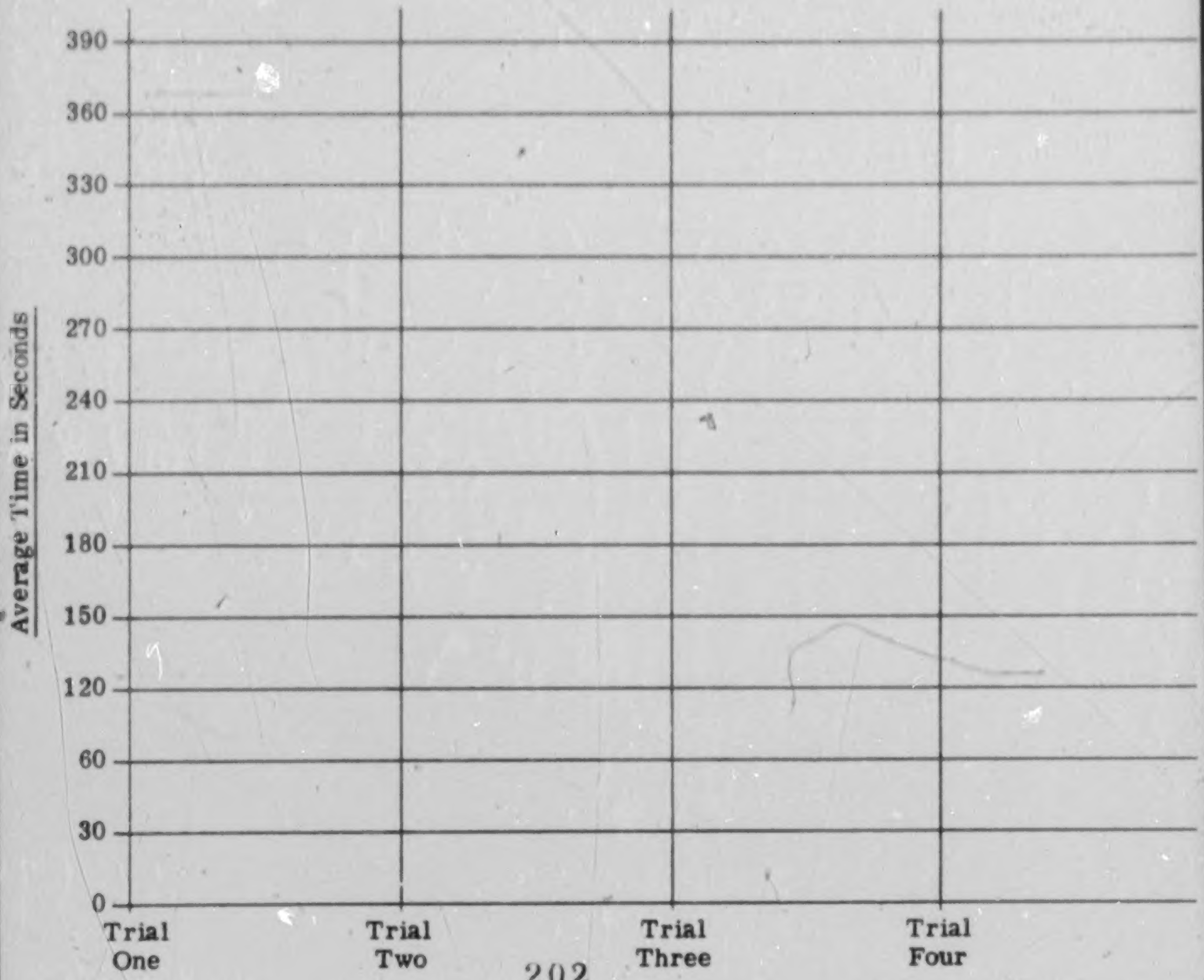
47-1

EFFECT OF NOISE ON SIMPLE LEARNING

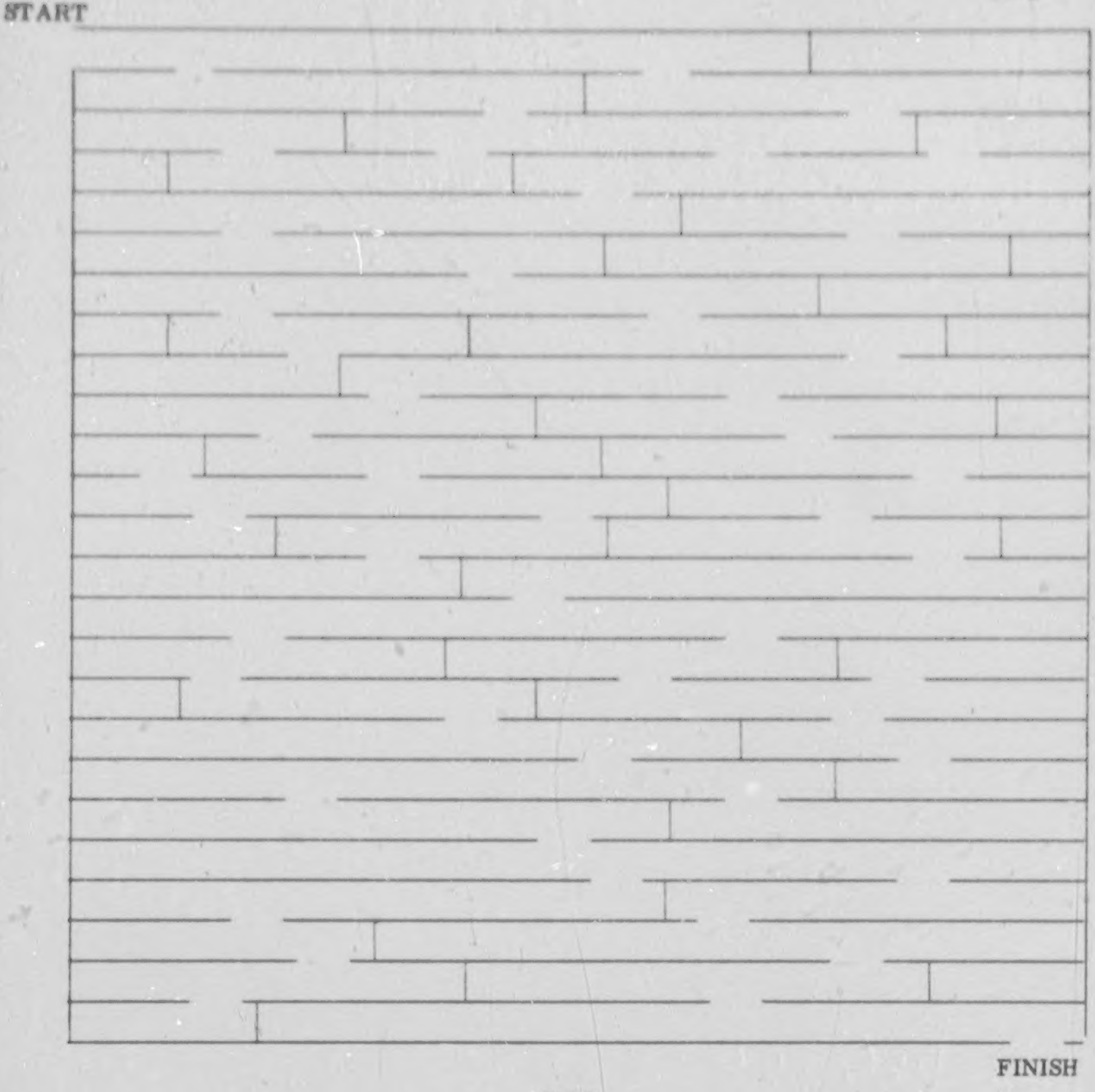
Legend: △ Control
○ Experimental

Name ____________

Date ____________



47-2


START
FINISH

INFORMATION CARD

Noise is an Invisible Pollution

Noise -- its everywhere.

Noise is a danger to our health and welfare. It endangers our hearing. It may even be affecting our hearts and other body functions.

Who are the producers of noise? They include jet planes, trucks, buses, trains, lawnmowers, motorcycles. Noise also comes from jackhammers and other construction equipment. It comes from blenders, saws, and dishwashers.

We cannot get away from noise. It follows us everywhere. The only alternative is to stop making so much noise. It is time to turn down the volume.

In response to growing public protest, Congress enacted the Federal Noise Control and Abatement Act in 1972. Under this law, EPA will begin to take steps to make life in the U.S. quieter. Here's how:

- EPA will study the effects of noise. It will issue regulations. These will set the maximum noise levels necessary to protect public health and welfare.
- EPA will issue noise-emission standards for the major sources of noise in the environment. These include trucks, trains, buses, construction equipment, motors and electrical equipment.
- EPA will propose regulations to control aircraft noise and sonic booms. These will be submitted to the Federal Aviation Administration. The FAA will use them to establish and enforce aircraft noise standards.
- EPA will certify low nose-emission products. The Federal government will buy these whenever possible.
- Noisy products will have to be labeled with their noise--emission levels.

--Your World, My World. Washington:
Gov't Printing Office, 1972 ($1.50)

NOISE By Cathy Christensen*

A true danger is impending in the area of noise. Noise, like smog, is a slow agent of death, states Dr. Vern O. Knudson. The word noise comes from the same Latin root as the word nausea.

Memphis has won the quietest city in the United States for thirteen consecutive years. Besides ordinances against excessive hornblowing. They slap out summonses for yelling, hooting, or whistling in public streets between the hours of 11p.m. and 7a.m.

A large majority of authorities consider noise as an irritant, contributing to tensions that can be injurious to a person's health. Some psychiatrists and psychologists tend to believe that in unusually high noise levels (such as transistors, traffic sirens, whistles, children, blaring television sets) just one extra "startle sound" may create an act of violence. A startle sound may be a scream, ringing of a telephone or a dropped toy.

In certain portions of Brazil, the Brazilians add noise-makers to their cars to add to the roar of the city. They hold polite sidewalk conversations by yelling over the din. It is said the people actually enjoy the racket. The noise is hardly considered loud to the citizens, but the tourists give up the marvleous view of the city to get away from the roar. Some say travel might cure the roar of Brazil. It is hoped that sooner or later Brazilians will realize that machinery does not have to sound powerful to satisfy it's users. A photographer from Brazil said, "I'll never forget the first time I went to Miami. All those cars! The hustle! And almost no noise! For a while there, I really thought there was something wrong with my ears!"

Some steps are being taken to give people a quieter life, other complexities are arising to emphasize the problem. The clamor of modern day living continues to mount.

*Cathy Christensen is a junior high student in Brevard County. This information is condensed from a research paper she did on noise.

the problem:

Some animals are considered harmful to man. Others are considered helpful. Find out all you can about one from this list: honeybee, housefly, ladybug, cutworm, dragonfly, silkworm, termite, moth, bumblebee, mosquito, and lovebug.

clues for you:

Start by reading about one of the animals listed above. Some things you will want to look for when reading:

1) its life cycle
2) what it eats
3) what eats it
4) how it affects man
5) methods used to control it

If this animal is found in your community, look around for evidence of the animal in action.

Try to follow one of these animals around for a few minutes. Record the things it does.

Report to the class. Is this animal considered helpful?

Materials:
animal reference books
drawing paper
pen or pencils
colored pencils

other ways to look at it:

.. Why are some animals considered harmful? Do we really mean harmful to man?

.. What other things would be affected if this animal disappeared?

.. Do any of these animals affect you directly? Indirectly?

.. Does the control of this animal's population affect you in any way? Is it possible to do more harm trying to control a pest than the pest does itself?

.. Survey your community for plants that are considered harmful. Make a list of the poisonous plants in this area. What would happen if these plants were destroyed?

.. Study one other plant or animal for its effect on the community.

.. Invite someone from the local mosquito control agency to talk to the class about ways mosquitoes are controlled.

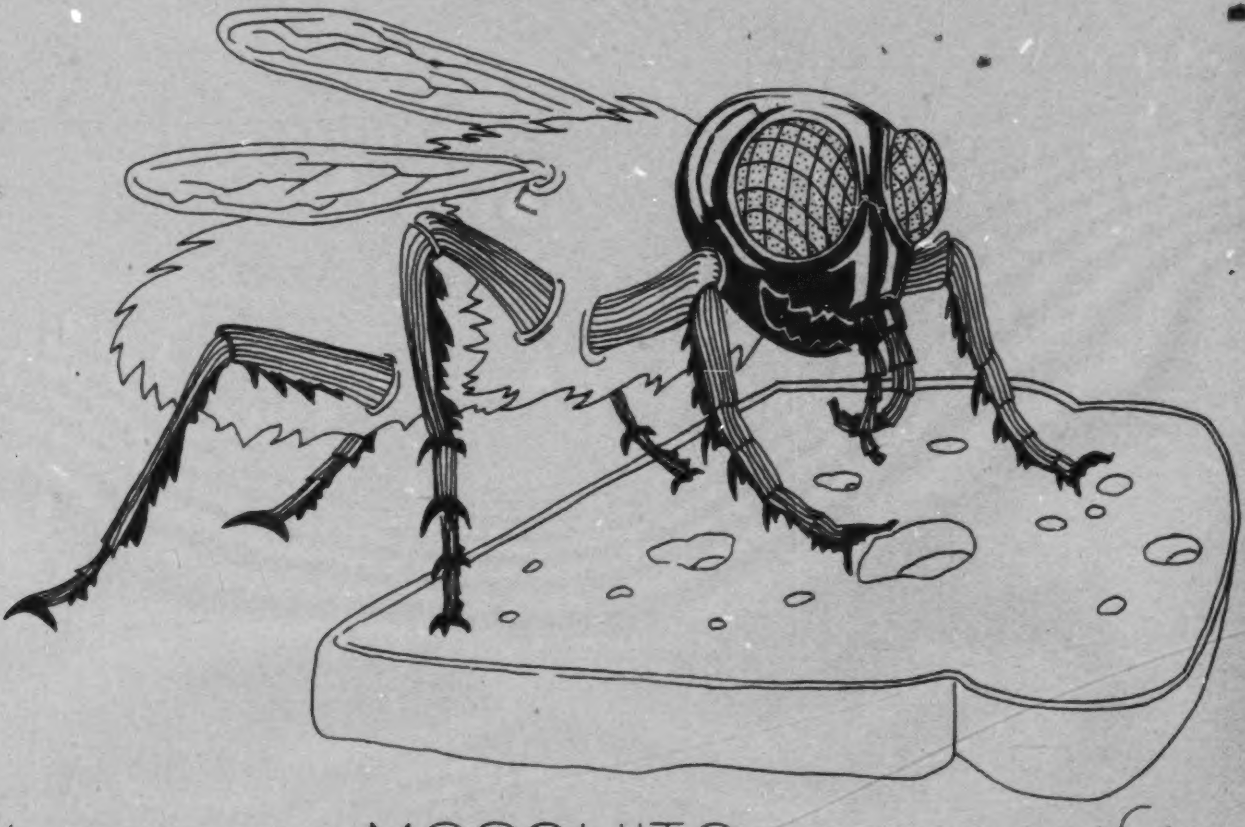
what did you discover?

Draw one of the animals you studied on a piece of paper. Draw around it all of the things that it affects, or that are affected by it. Do you think this animal does more harm or good?

HONEYBEE

DRAGONFLY

TERMITE



SILKWORM

MOSQUITO

LADYBUG

the problem:

Should man discontinue the use of chemical pesticides?

clues for you:

Try to design an experiment using a natural pesticide. Read the information cards, The Scientific Investigator, Using Natural Pesticides and Garlic Pesticides. When you have designed your experiment, take it to your teacher for approval. Then, try it. How well does your pesticide work? Does it kill the insects or just repel them?

Survey your community to find out what pesticides people in your community are using. Are they using the persistent pesticides? Give them a list of the safe chemical pesticides. Ask them to use these.

Materials:

information cards, Using Natural Controls (49-7), Pests—Some We Need, Some We Don't (49-1), and Garlic Pesticide (49-8)

articles on pesticides

other ways to look at it:

.. Consider the following situation:

A group of conservationists is urging a ban on the use of DDT in the state of Florida. Grove owners and mosquito control officers are fighting the ban. Homeowners and businessmen are divided on the question. The governor has scheduled a hearing to discuss the proposed ban.

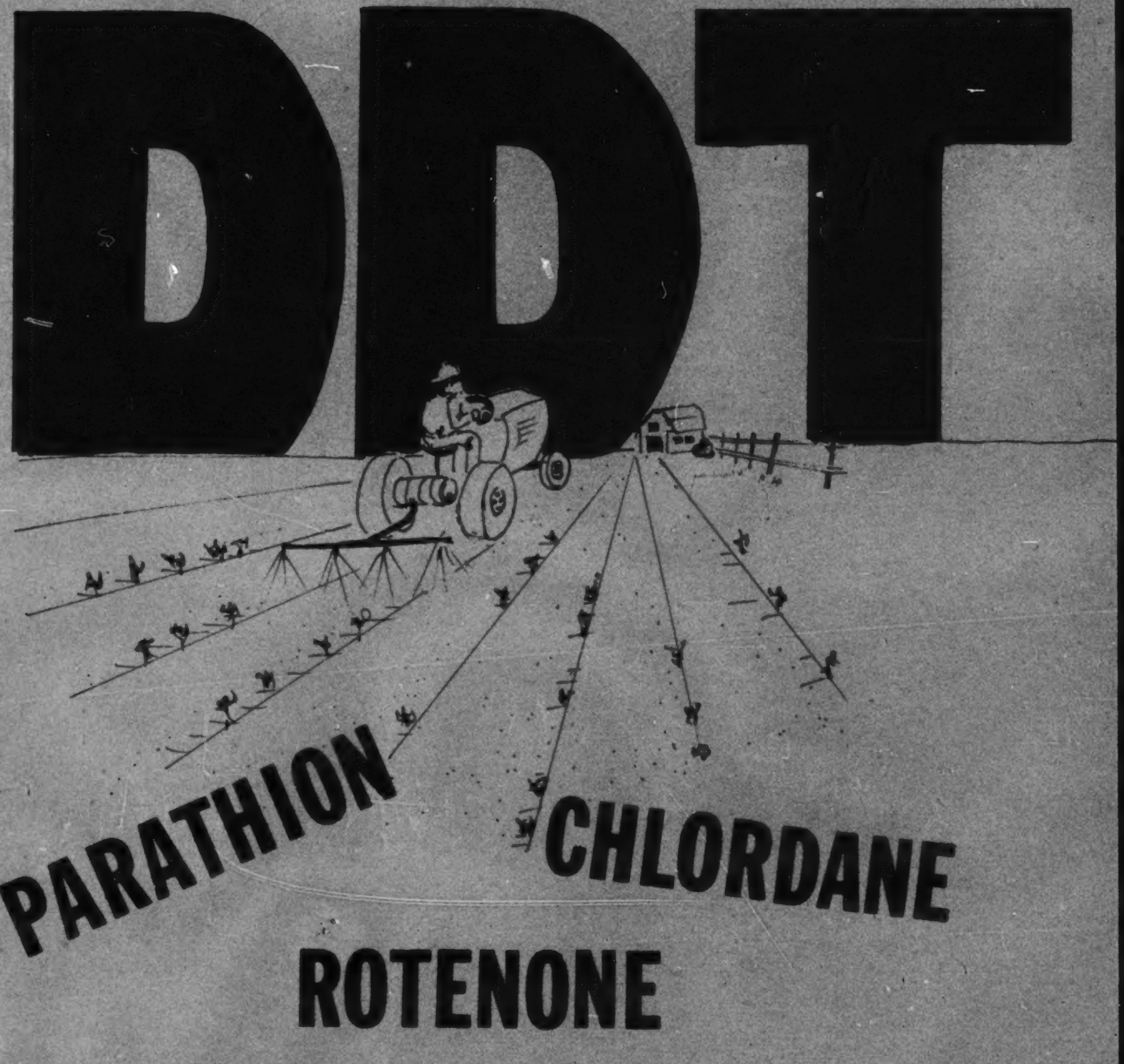
Assign the part of each one to a group of students. Have them research their position on the use of pesticides. They can use the references listed below as a start. Hold the hearing and make a decision based upon the arguments presented.

.. Find out about new research being done in pest control. Are there any promising developments?

.. What is the role of the EPA in regulating pesticides?

what did you discover?

Make a list of recommendations on the uses of chemical pesticides.


DDT
PARATHION
CHLORDANE
ROTENONE

INFORMATION CARD

Pests—Some We Need, Some Don't

- A short history of pesticides---

We have been using chemicals for many years to control pests. These chemicals are called pesticides. The ending (-cide) of this word comes from the Latin, "Cide." It means "to kill." Insecticides are used to kill insects; rodenticides to kill rats; fungicides to kill fungus; and herbicides to kill plants. The early pesticides were arsenic compounds or sulfurs. They killed the insect only when it ate the compound.

A major breakthrough in insect control was made by a research chemist, Dr. Paul Muller. He discovered dichloro-diphenyl-trichloroethane (DDT). DDT is a nerve poison. Paralysis spreads from any part of the insect's body that comes in contact with the chemical. It is very effective even when sprayed only on surfaces over which the insect may crawl. It also lasts for a very long time. DDT was used freely during and after World War II. It made large areas of the world free from malaria.

In the past twenty years the number of deaths through disease has decreased throughout the world. This is due mostly to the use of pesticides. They killed many of the insects and rodents which carry the diseases to man. Pesticides have also helped increase food production greatly.

- The problems with pesticides---

Pesticides are poisonous, of course. They can cause illness and even death. Over 200 humans die each year from pesticide poisoning. Some of the newer pesticides have another danger. They are called persistent compounds. This means they persist, or stay, in the environment for many years. They do not break down in nature's recycling system. DDT is an example of this type of pesticide.

Pesticides like DDT have been carried to every corner of the world. Small living creatures eat the chemical. They are eaten by larger and larger creatures. Each time, the DDT or other pesticide in the animal's tissue is transferred. Finally, the pesticides reach the animals at the top of the food chain. By that time, the animal may have levels of pesticides in its body several times that found in the environment. The pesticide may kill or weaken the animal. It may cause side effects like thin egg shells or the production of fewer young.

A large part of the pesticides finally reach the ocean. Scientists estimate that one-fourth of the world production of DDT may be in the sea. Pesticide residues are found in almost all ocean fish.

The average American now carries about eight parts per million of DDT in his fatty tissues. Scientists do not know what effect this will have on humans.

Another problem with pesticides is that they may also kill other, helpful insects. Also, some of the insects that are sprayed survive. They breed more pesticide-resistant pests. Over 200 species are no longer affected by pesticides.

- Watching over pesticides---

The Federal government began regulating pesticides in 1947. In 1972, a new law was passed. The EPA was given the major responsibility to control pesticides. Here's how:

•All pesticides and factories where they are manufactured must be registered by EPA.

•To be registered, a pesticide must be safe. It must be properly labeled, with directions for use. It must do what it says it will do.

•If a pesticide meets EPA standards, EPA registers it and classifies it. It may be classified general use, restricted use, or both.

•A general use pesticide will not cause unreasonable adverse effects on the environment.

•A restricted use pesticide may adversely affect the environment or injure the person applying it. A restricted use pesticide may be used only under the direct supervision of a certified applicator. Certified applicators have been trained to apply dangerous chemicals.

•EPA studies the effects of approved pesticides. If a problem develops, EPA also has authority to seize registered pesticides that have been misbranded or that damage the environment.

•EPA sets the limits of pesticide residues that can be in our food or in feed for animals. The Food and Drug Administration enforces these limits. It may seize any food that contains too much pesticides.

•Anyone violating the pesticide control laws may be fined up to $25, 000 and be sentenced to one year in prison.

•EPA monitors pesticides in the environment and conducts research on the effects of pesticides.

• A Look at the Future---

Scientists are looking for new ways to control pests. Some of the methods they are investigating include the use of natural predators and parasites, developing insect-resistant crops, producing sterile insects.

Resources:

MacMullan, Ralph. The Case Against Hard Pesticides. Washington: National Wildlife Federation, 1968.

"Pesticides." Ranger Rick's Nature Magazine, May-June, 1971.

Pesticides. Washington: Environmental Protection Agency, 1971.

Your World, My World. Washington: U. S. Government Printing Office, 1972.

INFORMATION CARD

The Brown Pelican: An Endangered Species Making a Comeback

The best-known nesting colony of the Eastern brown pelican is on a mangrove island called Pelican Island. It is located in the mouth of the Indian River across from Sebastian. It is at the southernmost tip of Brevard County.

One of the earliest protectors of Pelican Island was Paul Kroegel. He came to Sebastian in 1881 at the age of 17. He was hired by the American Ornithologists' Union and depended on an old 10-gauge shotgun for authority. Kroegel guarded the birds on the island from vacationers who shot the birds for sport.

In 1903, President Theodore Roosevelt named Pelican Island a national bird reservation. It was the first national wildlife refuge. Kroegel became the first warden. His pay, according to his daughter who still lives in Sebastian, was $15 per month.

Early in the 1920's the pelicans abandoned this island, because the mangroves had been destroyed from overuse. Today, both mangroves and pelicans have returned. In 1963, Pelican Island was named a National Historic Landmark. At the present time, pelicans nest there nearly 11 months a year. They are accompanied by egrets and herons. In this refuge, the pelican is protected by law from hunters and sightseers.

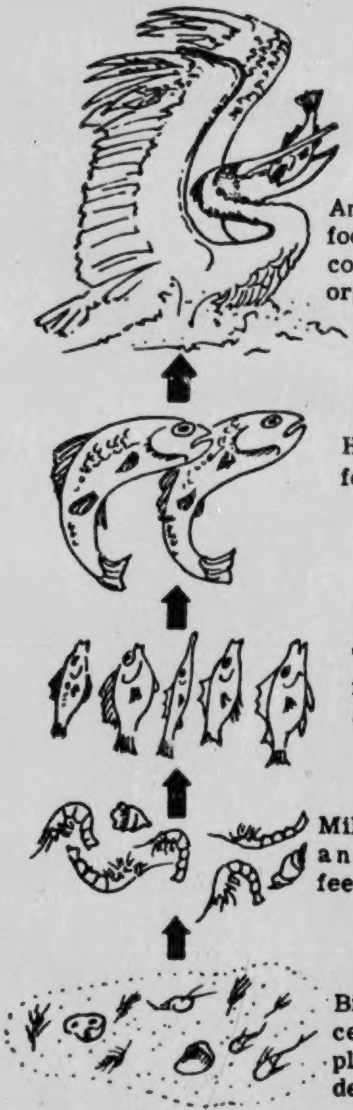
Studies made in California in 1969, showed that established pelican nests there contained few eggs, most of which were broken. The reason for the broken eggs appeared to be thin or spongy shells. Most of the time the weight of the pelican was enough to break the shell. In South Carolina and Florida the brown pelican is still abundant. Even there, shell thicknesses have decreased up to 18% since 1947. Scientists examined eggs from the California nesting areas further. The eggs showed extremely high levels of DDT in all parts of the egg. Scientists believe that this is responsible for the thin shells.

The brown pelican feeds only on marine fish. In California, fish in the coastal waters are more contaminated than fish in fresh water. Scientists predict that unless DDT levels in coastal waters are lowered, the brown pelican is in trouble. Pelicans in both California and Louisiana (the "Pelican State") have been sharply reduced. The drawings show why. DDT and other biocides ("killers of life") became more concentrated as they move up the food chain. DDT does not disappear when an animal dies. It is returned to the soil. The vicious cycle begins again.

Studies such as the one in California have led to decreasing use of DDT and other persistent pesticides. The pelican populations of California and Louisiana have already been almost wiped out. Recent evidence is that the pelican is making a comeback in Florida.

The Florida Game and Fresh Water Fish Commission has conducted a research program on the state's pelican population. The pelican population has remained stable at about 20,000 for the past six years. This seems to be because concentrations of DDT are finally beginning to drop. Pelican eggs in Florida were measured throughout the six-year study. The study showed that they had become somewhat thinner. They were still thick enough for the young birds to hatch.

The pelican population appears safe. It has been possible to ship about a hundred birds to Louisiana each year. Scientists hope to rebuild the population there. The same may eventually hold true for California.



Animals at the top of the food pyramid get biocides concentrated from all the organisms below.

Hundreds of bigger fish feed on the smaller fish

Thousand of small fish feed on the shrimp and snails.

Millions of shrimp, snails, and other small animals feed on the layer below.

Biocides first enter the cells of countless tiny plants and animals, both dead and alive.

The fate of the pelican (as well as that of many other species of birds) in this country depends on the quality of the coastal water in Florida. If DDT and other pollutants can be controlled, Florida may follow in the tradition of Pelican Island and Paul Kroegel. It may become the key to saving many species. If Florida's coastal waters are polluted, the effects could be disasterous. This state represents the "last chance" for so many species. It is important that its citizens become aware of the dangers of biocides such as DDT. They must take steps to protect the environment against such substances.

-**Laycock, George. "Where Have All the Pelicans Gone?"** Audubon, **September 1969.**

-Moore, Jere, Jr., Associated Press Writer. "Pelicans Back in the Running." Today Newspaper, Wed., July 11, 1973, p. 6B.

Questions for Thought

1. What drove the pelicans from Pelican Island in the 1920's?
2. How did DDT affect the pelican population of California and Louisiana?
3. How does DDT get from the field where it is sprayed to the pelican?
4. Why is it especially important that Florida residents be aware of the ecological dangers of substances such as DDT?

VOCABULARY

1. ornithologist: a scientist who studies birds
2. abandoned: left
3. abundant: existing in great numbers
4. biocide: a substance which destroys life
5. persistent: long-lasting
6. conducted: held or run
7. stable: changing very little

USING NATURAL CONTROLS

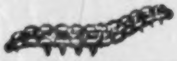
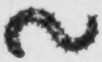
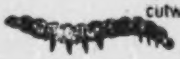
Avoid these chemicals in pesticides. They stay in the environment for many years.

aldrin
DDT
heptachlor
mercury
phosphorus
chlorthion
parathion
TEPP
BHC
TDEO
toxaphene
ANTU
thillium
demetron
phosdrin
EPN
endrin
arsenic
dinitro compounds
pentacholrophenol
sodium fluoracetate
dimethoate
schradan
chlordane

Below is a list of pesticides which are less damaging to wildlife, and they have not yet been proven harmful to human health. Use them, if you must, with the utmost caution, because little is known about their environmental effects. Abate, for example, kills crustaceans at the doses recommended for mosquito control. Malathion and diazinon are toxic to fish. Until further testing, most of these pesticides should not be used around the home.

malathion
abate
methoxychlor
dibrom
rotenone
carbaryl (sevin)
diazinon
pyrethrum

Sources: "Pesticides", Ranger Rick's Nature Magazine. Reprint and Pesticides--The Mist of Death. New Haven, Conn.: Pendulum Press, 1971.

PEST	NATURAL CONTROL
Ant, cockroach	Mix equal parts of icing sugar and powdered borax Sprinkle in corners and along baseboards OR Use Dri Die, Drione, or Silica Gel Spray
Aphid	Same as for mealy bugs and thrips Also plant nasturtiums in garden OR Cut up 3 pounds of rhubarb leaves or cider leaves Boil ½ hour in 3 quarts water Strain Cool Dissolve 1 oz soapflakes in quart of water Mix the two and spray
Beetle, bug, caterpillar (other large insects)	Pick pests off and put them in a can of kerosene or oil
Cabbage looper, carrot fly	Plant one of these herbs between rows of cabbage or carrots: sage, rosemary, mint, leeks, hyssop
Cabbage worm 	Plant rosemary or thyme in garden. Yellow jackets are a natural enemy. OR Cover plants with cheesecloth to prevent laying of eggs by the adult moth. OR Sprinkle rye flour over and around plants when covered with dew
Carrot fly	Plant onion sets (not seeds) between rows of carrots
Cotton bollworm, tobacco budworm	Green lacewing larvae (aphid lion) or ladybug adults and larvae*
Flea beetle	Plant catnip here and there in border
Japanese beetle	Plant garlic, rue, or tansy (herbs) near roses and raspberries
Lice, mites on house plants	Spray plants with plain soapy water
Mealy bug, thrips, mite, red spider	Green lacewing (aphid lion) adults and larvae Ladybug adults and larvae* Praying mantis** (collect egg sacs in winter and place in garden)
 **Millipede, wireworm**	Punch holes in sides and bottom of tall juice can Bury upright in garden border Fill with potato or carrot peelings Empty can weekly
Mole	Plant an herb called "mole plant" *(Euphorbia lathyrus)* here and there in flower garden
Mosquito	Dry up stagnant water to kill larvae. Put up a purple martin birdhouse in your yard
Moths around lights	Use frosted-coated yellow or red outdoor light bulbs
Onion fly	Plant onion sets, not seeds
Potato bug	Plant horseradish, dead nettle, or flax in potato patch
Slug, snail, cutworm 	Place a cabbage leaf upside down on ground They will gather underneath OR Place a wide shallow pan of stale beer, sunk level with the ground Clean out weekly
Sowbug, earwig	Remove any piles of decaying garden refuse or trash, boards, bricks or logs
Tomato worm	Plant asparagus or borage near tomatoes

INFORMATION CARD

Garlic Pesticide

To make a garlic spray: Use 3 oz. chopped garlic bulbs (can use bought garlic bulbs, though organically grown ones are much better). Let them soak in two teaspoonfuls (50cc) of mineral oil for 24 hours. Add 1 pint of water in which 1/4 oz. of oil-based soap (i. e. Palmolive) has been dissolved. Stir well. Strain the liquid through fine gauze and store it in a glass container (it reacts with metal).

Try it against the worst insect pests you know. Start with a dilution of 1 part to 20 parts of water. Then go down to 1 part to 100 so you use as little as possible.

In past research, it seemed that garlic worked well as a pesticide sometimes but sometimes not. It seems that the most important thing about the garlic spray is that it should be made from garlic grown in humus rich mixture.

Try to grow your own garlic. Buy bulbs from a grocery or health food shop. Split them into their cloves. Plant the cloves with the pointed noses just below the surface. Keep them 6 inches apart. Leave a foot between the rows. Plant in well-composted soil in full sun. Lift them out when the foliage dies. Store in dry area until ready for use.

Garlic will not harm animals or people. In fact, there are some indications that it may improve the health of the body. It is helpful in repelling fleas and mosquitoes as well.

Hills, Lawrence D. Organic Farming, September 1972.

the problem:

Can you design a closed environment?

clues for you:

Plan a closed environment for a small animal in your area. The environment must have everything the animal needs. The wastes from the animal must be recycled. The animal must be in its natural surroundings. Don't forget temperature and moisture.

As a double check, ask yourself these questions. What will this animal eat? How does it breathe? Will there be enough oxygen? Will the plants I have chosen live in this environment?

Present your plan to your teacher. If your teacher approves, try setting up this environment. Keep a record of your observations. Did your plan work?

Materials:

paper and pencil
drapery rings
bread
glue
tempra paint
oaktag
tissue paper
dried flowers

other ways to look at it:

.. Make a chart. Show which things depend on the water, the animal, the soil, the green plants.

.. Can you remove any of these things and still have the rest survive?

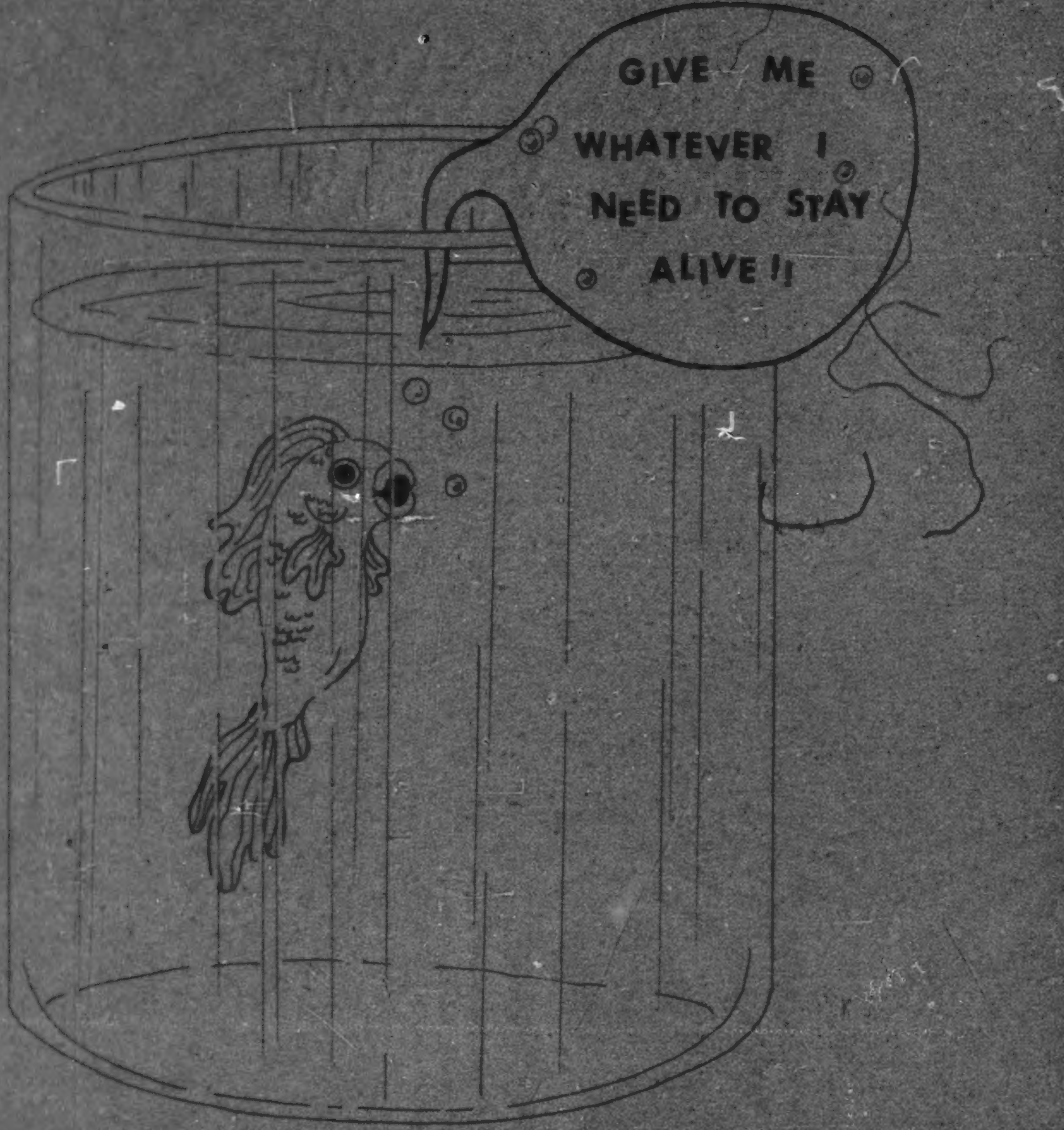
.. How is this animal adapted to the environment you designed? Could it survive in a completely different environment?

.. How does nature recycle the materials in this closed system? Are new materials ever added?

.. Make mini-models of animals and their habitats. Start with a round drapery ring. Cut oaktag to cover the back. The oaktag will be the habitat. You can tissue-collage it or just add dried flowers. Add the animal of bread clay and watercolor. (Your teacher has the recipe for bread clay.) Attach the oaktag to the ring.

what did you discover?

Draw a model of your closed environment. Using arrows, show how each thing in the environment can be used by another.



GIVE ME WHATEVER I NEED TO STAY ALIVE !!

the problem:

Where does your food come from?

clues for you:

The cover of this card shows a drawing of a food chain. A food chain traces the food back to its original source, the sun. Start with the bird. Trace the energy in the food back to the sun.

Try making a food chain poster of your own. Write down everything you ate for breakfast or lunch. Now trace each food back to its original source. Make a poster to show this. You can use pictures from magazines or draw your own.

Read the information card, Niches. Using the food chain poster you made, identify the producers and consumers. Identify the herbivores and carnivores.

Materials:
information card, Niches (51-1)
construction paper
magazines
pens, glue, scissors
United States map

other ways to look at it:

.. Make a mobile of one food chain. Put the sun in the center.

.. Why are green plants so important? Write a science fiction story where all the plants are destroyed.

.. Did your food chains have any decomposers? Why are decomposers so important? It is hard to see decomposers at work, but try to find at least two decomposers in your school yard.

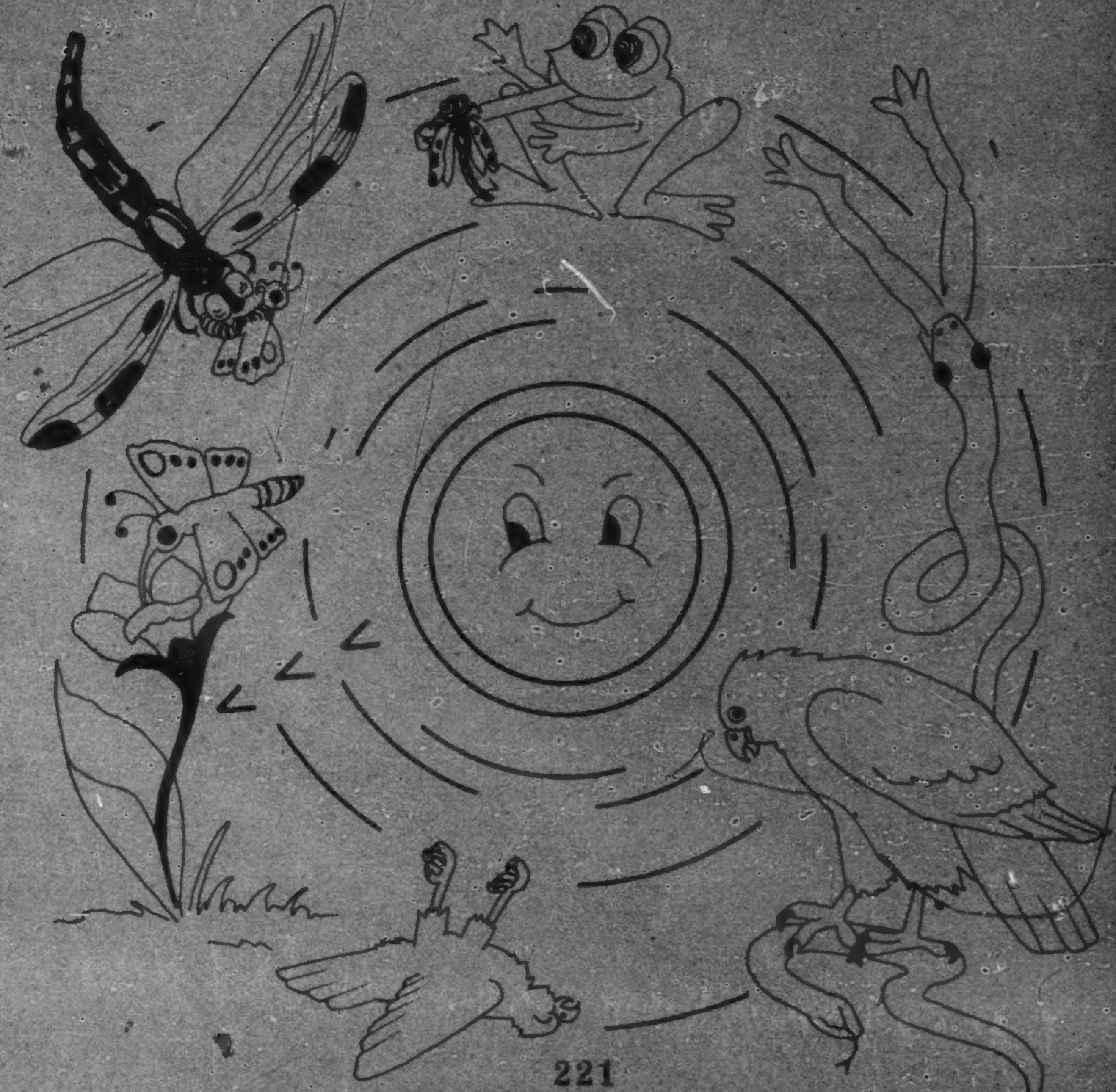
.. Look again at the food chain on the cover. Study each of the animals. List the adaptations of each animal that enable it to find the food it needs.

.. Using a map of the United States and your food chain poster, identify the region that each food comes from.

.. Predict what will happen if one of the animals in your food chain becomes extinct.

what did you discover?

Your teacher will give you a ditto sheet. Cut out the drawings and arrange them in a food chain.



INFORMATION CARD

Niches

In every community, there are "jobs" each plant and animal must perform in order to keep things in balance. Ecologists don't use the word "job." They use the words NICHE and ROLE. The place where the plant or animal can survive is its niche. The part it plays in the habitat is its role.

Every community must have PRODUCERS. The producers have the job of taking raw materials and turning them into food. The green plants of the community fill this niche. The sun provides the energy for the making of food.

All of the animals in the community depend upon the green plants. They are called CONSUMERS, because they consume, or eat, the green plants—either directly, or indirectly. Animals which eat only plants are called HERBIVORES. The next niche is filled by CARNIVORES, or meat eaters, which feed on the herbivores. Carnivores are also called PREDATORS, and the animals they they eat are their PREY.

There are other niches in the community. PARASITES fill one. They feed on other living things (called HOSTS). There are both plant and animal parasites. SCAVENGERS fill another important niche. Scavengers are consumers that feed on dead plants and animals. Gulls and vultures are scavengers. The last niche belongs to the DECOMPOSERS. Decomposers feed on dead plants and animals. They break down the materials in the dead bodies and return them to the earth and sea. The decomposers are very important. Only after the materials have been broken down can they be used again. Bacteria and fungi are decomposers. The next time you see a mushroom, you will recognize nature's recycling plan at work.

There are some roles in nature where two things live in partnership. To find out about this, read the card, Partners.

— Miller, Shirley. The Story of
Ecology. New York: National
Audubon Society.

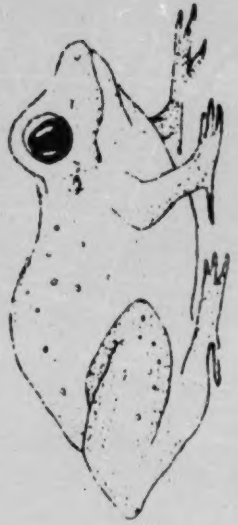
Niches

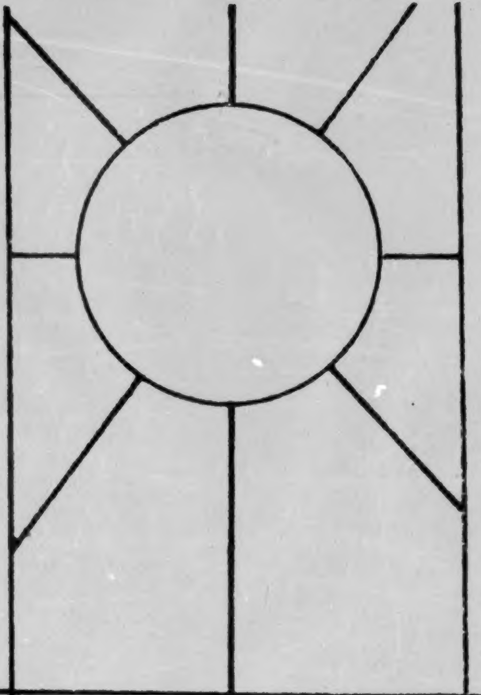
Questions for Thought

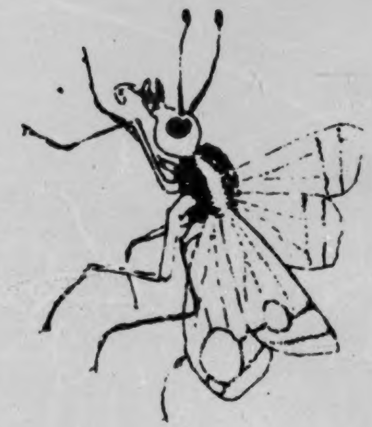
1. To see if you understand niches, draw a nutrient cycle. Start with carbon dioxide, water, sunlight and a green plant. See if you can follow the energy and materials from the plant until they are returned to the universe. Label each niche in the cycle.
2. "Bacteria are man's best friend." Explain.
3. What is the ultimate source of energy for all life?
4. What is necessary in order to use this energy?

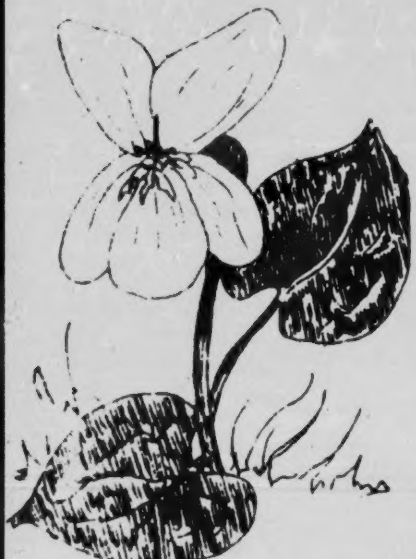
VOCABULARY

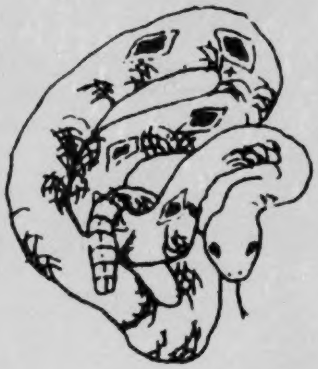
1. habitat: the place where something lives
2. recycling: repeating a pattern over and over
3. nutrient: a food





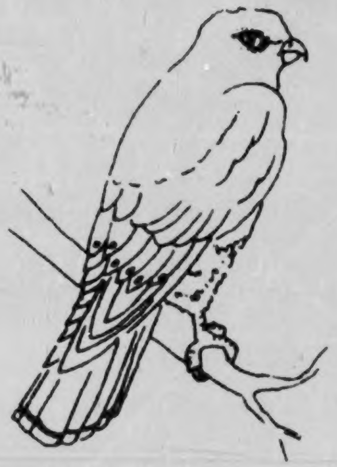






EVALUATION FOR FOOD CHAIN

CUT OUT PARTS OF THE FOOD CHAIN ABOVE. PASTE THEM IN ORDER ON ANOTHER SHEET OF PAPER.



the problem:

How complex are food relationships?

clues for you:

Food chains, as we have discussed them, rarely exist in nature. What does exist is a food web. Look at the information card, A Simple Food Web. A food web is several food chains woven together. Can you trace more than one food chain in the food web?

To make your own food web, pick one local, wild animal. Find out what eats it and what it eats. Show all these relationships on a poster. Trace each food back to its plant source. Draw arrows to show how the foods are interrelated.

Explain to the rest of the class why the animal you have chosen is important.

Materials:

information cards, A Simple Food Web (52-1) and Niches (51-1)

construction paper

felt pens or crayons

tissue paper

wire

yarn

other ways to look at it:

.. Does your web have a scavenger? Why are they important? Why don't people like them? Identify a local scavenger.

.. Make a food web canopy for your room.

.. How are the animals in a food web interdependent? Take one of your animals out of the food web. Predict what will happen to the rest of the animals in the food web. Are there any that are not affected?

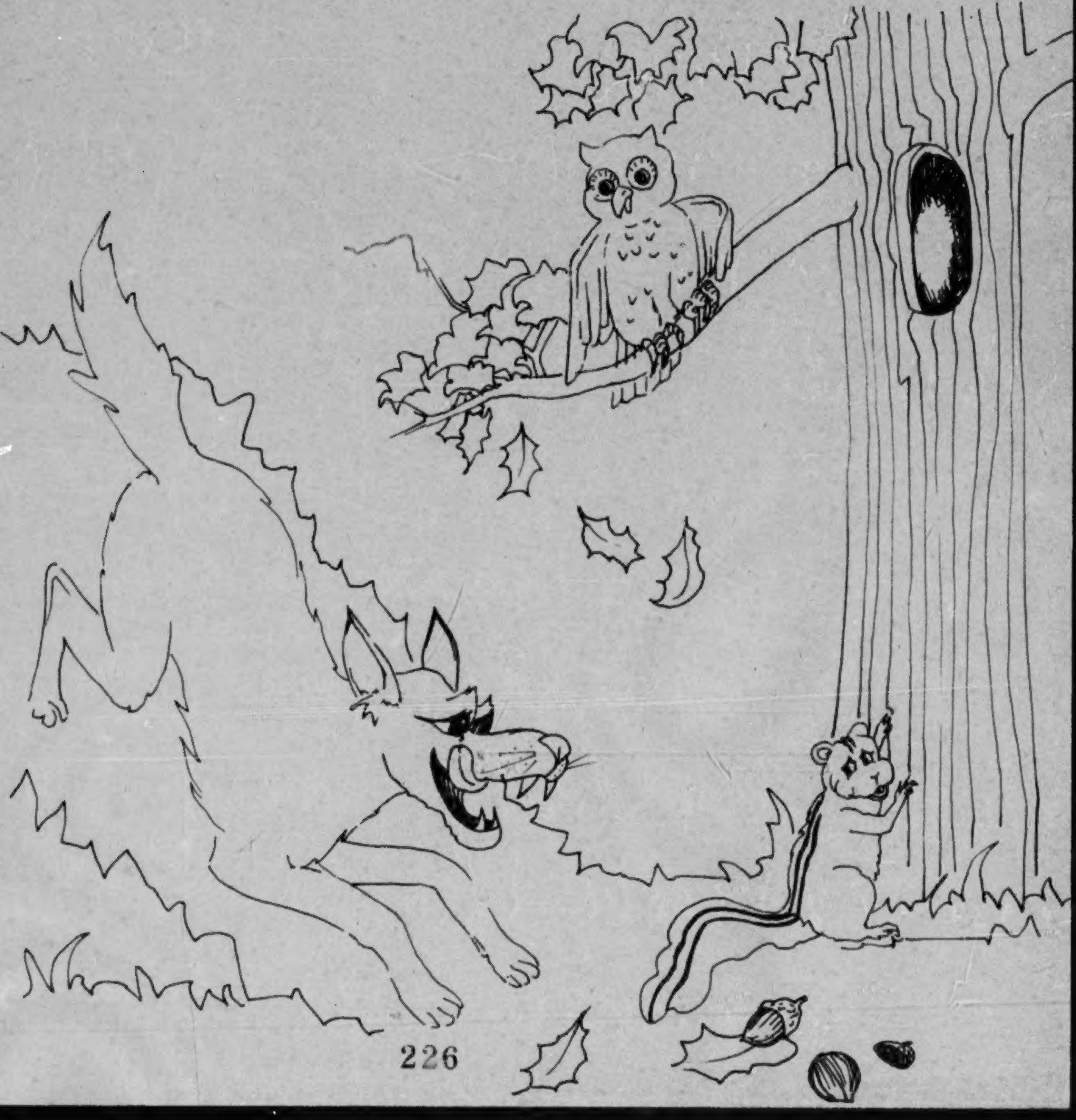
.. Write a poem or short story about decomposers. Title it, "Decomposers—Our Silent Heroes." Record it for the class.

.. Find out what a food pyramid is. Place the animal you picked in a food pyramid. What place does it occupy? Draw your food pyramid for the class.

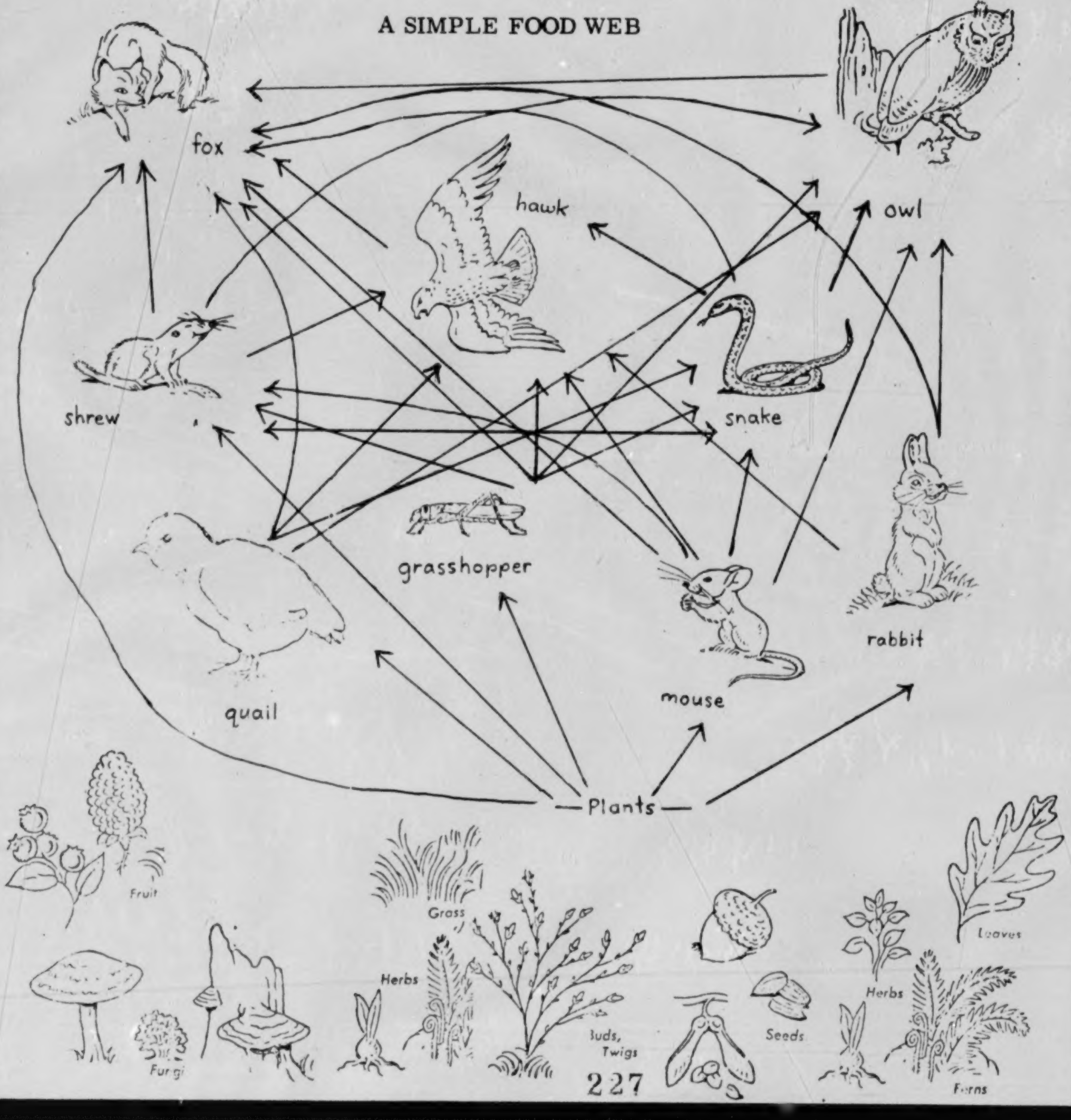
.. Explore a local habitat. Using your observations and research, put together a food web for that habitat.

what did you discover?

Display and explain your food web poster to the class.



A SIMPLE FOOD WEB


fox
hawk
owl
shrew
snake
grasshopper
quail
mouse
rabbit
Plants
Fruit
Grass
Leaves
Herbs
Herbs
Buds, Twigs
Seeds
Fungi
Ferns

the problem:

Why are predators important? (A predator is an animal that kills other animals for food.)

clues for you:

Many predators, like the coyote, are becoming scarce. Some states pay a bounty for their hides. Why do some people want predators killed? Why do other people think they should be protected? Read the information cards, Coyote—Still Scourge of the West and Wolves are Necessary.

Decide whether or not predators should be protected by law. Write a short article explaining how you feel and reasons for your decision. Post your article for the rest of the class to read. See how many people agree with you.

Materials:
information cards, Coyote—Still Scourge of the West (53-1) and Wolves are Necessary (53-3)
notebook and pencil

other ways to look at it:

.. Study the front of this card. The giant saguaro (suh-WAR-ro) cactus is in danger of disappearing. How is the saguaro cactus dependent upon the coyote for survival?

.. Make a list of all the animals that will be affected if the saguaro disappears.

.. Make a food web showing how the animals in the saguaro forest are interdependent.

.. Snakes are predators, too. Find out why snakes are important in the balance of nature. What would happen if all the snakes were destroyed?

.. List five predators in your area. List also their prey. What would happen if these predators disappeared?

.. Write a poem about one predator you like. Find a picture of that predator to go with the poem.

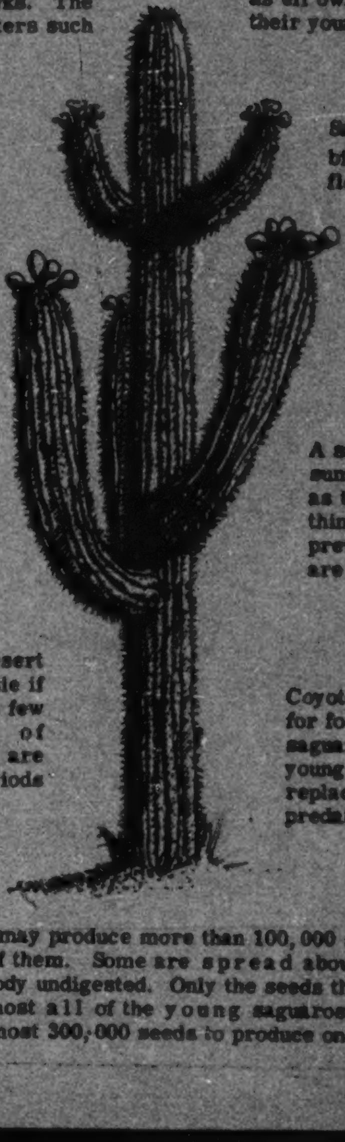
.. What is a bounty?

what did you discover?

Tell your parents why predators are important.

LIFE IN A CACTUS FOREST

Information adapted from Nature and Science, Feb. 16, 1970.



Saguaros, the tallest plants in the desert, provide a safe nesting place for red-tailed hawks. The hawks feed on plant-eaters such as rodents and rabbits.

High in the trunk, woodpeckers chip out nesting holes. After the young woodpeckers leave, the nest is abandoned. Then, other animals use the hole as their home. Insects find shelter there. Other birds, such as elf owls, purple martins, and sparrow hawks raise their young there.

Saguaro flowers only bloom for a few days. Bees, bats, and birds that drink the nectar in the flowers help pollenate the flowers so seeds can develop.

Some kinds of insects, such as the saguaro moth, could not survive without the cactus. The moth lays its eggs only on this cactus. It also carries a bacterial disease that infects the cactus.

A saguaro stores water during the short rainy season in the summer. The plant gets thicker and the "pleats" spread apart as the water is stored. During the dry winter, the cactus gets thinner as the water is used. A waxy outer covering helps prevent the loss of water. Leaves, which normally lose water, are replaced by thin, sharp spines.

Shade means life during the desert day. A lizard or snake may die if it stays in the sun more than a few minutes. With the exception of birds, most desert animals are inactive during the hottest periods of the day.

Coyotes, hawks, and other predators (animals who kill others for food) help control the number of animals who eat the saguaro. If rodents become too plentiful, they will kill all the young saguaros. As the older ones die, they will not be replaced. In parts of Arizona this is happening because the predators are becoming scarce.

A saguaro may produce more than 100,000 seeds each year. Rodents and birds eat many of them. Some are spread about the desert as they pass through an animal's body undigested. Only the seeds that fall in the shade have a chance to grow. Almost all of the young saguaros are eaten by insects and rodents. It takes almost 300,000 seeds to produce one adult saguaro!

INFORMATION CARD

Coyote—Still Scourge of the West

Sheepmen throughout the west are howling like coyotes these days. Many say the hungry coyotes are forcing them out of business. "Coyotes are eating me out of house and home," drawls rancher, Charles Pents, of Morgan, Utah. According to Pentz, he has lost well over 200 sheep a year since a federal ban on predator poisoning took effect.

Conservationists are howling back. They say the coyotes shouldn't be poisoned. "I cannot see how we can justify poisoning," declares Barry Keller, an assistant professor of population biology at Idaho State University. "The majority of sheep are grown on public land. Why should the taxpayer pay for poisoning wildlife on his own land for the benefit of a small private industry? We must consider the value of the land as a wildlife and recreation area."

Government agencies at the moment are caught in the middle of the fight. They must decide which claims are valid. Are the coyotes really destroying the sheep industry? Should the coyotes be protected? The agencies are generally trying to help the stockmen with nonpoison forms of predator control. They are encouraging bounty hunting, research, and statistic keeping.

Several biologists at Idaho State University generally believe that sheepmen are misreading the impact of coyotes, the effects of the poisoning ban and public responsibility. Plant ecologist, Karl Holte, says he has seen only four coyotes in his eight years on the ranges of southeastern Idaho. "The thing that scares me about a poison program is that people don't know or even care what they are killing," Holte says.

"One purebreed sheep raiser in western Idaho reported losing 40 percent of his lambs to coyotes," says Roscoe Rich. Rich becomes disgusted when environmentalists argue that sheep raisers should accept certain losses for the privilege of grazing on public lands. One of Wyoming's largest sheep ranchers, Van Irvine, has announced he is being forced out of business. We have been suffering increasing and intolerable losses to coyotes." Irvine is shifting to cattle raising.

The Montana Livestock Department reports that 60% of the sheep growers in Montana's 29 largest sheep-producing counties have gone out of business in the last 12 years. The department says the sheepmen reported predator problems as the major reason for their decisions. Prices, lack of help, weather and disease were among the other leading reasons the sheepmen gave for giving up sheep raising.

Dr. Lee Talbot of the Federal Council of Environmental Quality says, "Emotional reports of livestock losses blamed on the inaccuracy of the control program are an annual event. We now recognize grazing on federal lands as a privilege." Talbot told Congress he cannot understand the views of some livestock producers because the use of poisons against predators "has not proven effective in providing protection for these livestock producers."

Virtually every sheepman who comments on the problem, and many government officials say coyote populations are increasing, not only because of the poison ban, but because of an unexplainable quirk of nature. Litters of coyote pups seem to be increasing in numbers.

Most sheepmen have formed groups to hire bounty hunters and bring in government agents to trap coyotes or shoot them from helicopters. Most say the hunting has paid off.

— Garry Moes. Today Newspaper,
Sunday, July 15, 1973.

VOCABULARY

1. predator: one who preys on others
2. bounty: a reward paid for killing certain animals
3. impact: effect
4. privilege: right, special favor
5. intolerable: cannot stand, horrible
6. inaccuracy: not correct
7. quirk: a trick

INFORMATION CARD

Wolves are Necessary

Do you remember the story about Little Red Riding Hood? Or the story about the three little pigs?

Who was the villain in these stories?

Right. It was the wolf.

Ever since man first began telling stories, wolves have usually been thought of as the "bad guys." They were considered killers who stalked deer, cattle and men. Few men thought wolves were good. Few remembered that they were the "grandparents" of man's best friend—the dog. Wolves were shot, poisoned, trapped and killed in every way possible.

Before the first settlers landed in North America, wolves lived all over the continent. They lived in cold places, in hot places, in forests, in prairies and in the mountains. But when civilization came, the wolf was in trouble. Wolves sometimes attacked man's domesticated animals such as goats and sheep. They were much easier prey than deer and rabbits. Way back in the 1600's, settlers in the eastern part of the United States began paying bounties for hunters who killed wolves. Soon there were very few wolves in the East. Bounty hunting was done until very recently. By 1908, there were only 200,000 wolves left in the United States and Canada. It seemed as if the wolf would soon be extinct.

About 30 years ago, some ecologists began studying the wolf. Their studies showed that wolves were intelligent, loyal animals. They worked together in families and packs to stalk and kill their prey. Many people felt that wolves killed just for fun. These ecologists found that they killed only for food. They also found that wolves played an important part in nature by controlling the population of grazing animals such as deer. Wolves kept herds of deer small enough that deer would have enough food. For this reason, many ecologists suggested that wolves be protected by laws so that they would not all be killed.

Not everybody agreed with this idea. Ranchers, farmers and hunters were afraid that there would soon be so many wolves that they would wipe out the deer. Then, they would start attacking sheep and cattle. Meat prices would go up if they had to spend more money protecting their livestock from wolves.

It was very hard for ecologists to prove their idea that wolves are useful in maintaining the balance of nature. But they finally found a perfect place to study the relationship between predator and prey. The place was an island in Lake Superior called Isle Royale. In the 1920's, Isle Royale was the home of a large herd of moose. Many of them starved to death. Soon only a few hundred were left. In 1936, a fire destroyed most of the forest on the island. After the fire, however, a strong new growth of bushes came up. For a while there was plenty of food for the moose, and the herd began to grow again. Ecologists worried that they would once again starve themselves to death. Then in the winters of the late 1940's, wolf packs crossed the ice to raid the moose herd. By the early 1950's, some wolves stayed on the island permanently. Since this took place on an island, ecologists were able to study very carefully the relationship between the wolf pack and the moose herd. They found out that a healthy moose was able to defend itself against the wolf pack. Usually it was a sick, young or old moose which the wolf pack killed. The wolves hunted only for food. As a result, the population of the moose herd stayed at about 600. There was enough food for all. This the scientists expected. They were surprised, however, to find out that the size of the wolf pack almost always remained at between 20 and 30 members. There were plenty of beavers, rabbits, mice and moose for the wolves to eat. Somehow, the wolves seemed to control their own population.

Studies like the one on Isle Royale have led scientists to believe that the wolf is a very important part of nature. Can they communicate this idea to people who still think of the wolf as an enemy to be killed? Many people still think of the wolf as the villain. Unless their beliefs are changed, there may not be any more wolves. That might be a good for Little Red Riding Hood, but would it be good for nature?

"Should We Protect Predators?" *Ecology: Habits and Habitats, Book B.* American Education Publications, Middletown, Conn., 1971, pp. 42-3.

Wolves are Necessary

Questions for Thought

1. Why have many men always tried to kill wolves?
2. Would you want a wolf pack living in the woods near you? Why?
3. Why did wolves almost become extinct?
4. Do ecologists think wolves are important? Why?
5. Why was Isle Royale a perfect place to study the relationship between predators and prey?
6. What happened to the moose herd on Isle Royale BEFORE there were any wolves? Why?
7. What happened to the moose herd AFTER wolves came to the island? Why?
8. What happened to the wolf population on the island? Why?
9. Will the wolf become extinct? Explain the reasons for your answer.
10. What can be done to prevent the wolf from becoming extinct?
11. Is it possible to protect the wolf and also protect farm animals and people? How?

VOCABULARY

1. villian: "bad guy"
2. domesticated: tame
3. bounties: reward for killing certain animals
4. grazing: grass-eating animals
5. permanently: lasting forever

the problem:

How can you examine a habitat? (If you don't already know what a habitat is, read the information card, Habitats.)

clues for you:

Select a habitat in your area to study. A large tree and the area under it would be a good place to start.

Start by recording your observations about the general appearance of the habitat. Note any animals you see moving around the habitat, any shrubs in the area.

Now, take a closer look. You will need to do a population count, examine the moisture, wind, and temperature and soil. The information cards, Measuring the Microclimate of a Habitat, Population Counts, and the activity cards on soil (see index) will help you. Record and discuss your results.

Materials:
information cards, Measuring the Micro-Climate of a Habitat (54-6), Population Counts (54-3), Habitat Survey (54-1), Habitats (20-1) and Partners (54-5)

other ways to look at it:

.. Select another habitat different from the first. Make a study of it. Contrast the two habitats and the life found there. Display your findings in chart form. Do the conditions in the habitat determine the type of life found there?

.. Repeat your measurements in these habitats every six weeks. What effect do seasonal changes have on life in the habitats? Keep a journal of your observations.

.. Look for examples of symbiosis in the habitat. To find out more about symbiosis, read the information card, Partners.

.. Make a model of your habitat. Display it in class.

.. Write a story about life in a particular habitat. Record it for the class.

.. Find an aquatic habitat near you. Make a study of it.

what did you discover?

Study your notes and write a paragraph (or draw a pictograph) showing the relationships between the living things, and the relationships of living things to the habitat.

habitats - habitats - habitats - habitats - habitats

54-1

DATA CARD

HABITAT SURVEY

Date ____________________ Time ____________________

Type of habitat ______________________________________

Things I saw when I first reached the habitat.

____

____

____

Things I found evidence of:

Non-living	Living Plants	Animals

Which animals are temporary?

Which animals live there?

HABITAT DATA CARD

Results of my investigations:

Soil Type ______________________ Soil Moisture ________________

Humidity ______________________ Wind ______________________

Temperature ___________________ Amount of Sunlight ____________

Interactions I saw:

Other measurements I took:

POPULATION COUNTS

Materials: coat hanger
pliers
pencil and paper
plastic bags

There are several ways to count numbers of different kinds of plants and animals, but this is one of the easiest.

Begin by bending the coat hanger into a square. Bend the hook into the square also. Before you go to the area you are to investigate, appoint someone in the group as a recorder. It will be their job to record all data you collect.

The procedure for taking a population count will vary depending on the size of the area you are investigating. If the area is small, you can simply close your eyes and toss the square. If the area is larger, it will require more samples. The best way to do this is by marking off a line straight through the area. Take your samples every meter, or every 5 meters, or every ten meters (depending on the size of the area to be sampled).

Each time you toss your square, follow these procedures:

1) List all the non-living things you find in the square.

2) Look for and record all animals in the square. Count numbers of each type.

3) Take one of each type plant you find. Place it in the bag. Count and record the numbers of each type plant.

Move to another area in the habitat and repeat the procedure.

When you return to the room, make a chart to display your findings. Be sure to include your number counts as well as types.

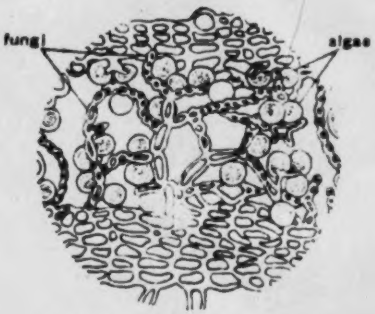
Your chart should look like this:

	Area I		Area I	
	Type	Number	Type	Number
PLANTS	____	____	____	____
	____	____	____	____
ANIMALS	____	____	____	____

INFORMATION CARD

Partners[1]

If you have ever seen a lichen (LY-ken), you have probably thought it was a remarkable plant. You may have seen lichens growing on bare rock. Well, it might surprise you to know that a lichen is really not a single plant at all. Lichens are combinations of two kinds of plants--algae and fungi. The fungus holds the algal cells and traps rain water. Together, as a lichen, they can survive in barren places that neither could live alone.



CLOSEUP VIEW OF A LICHEN

Scientists call this relationship mutual symbiosis, living together for mutual benefit. There are some partnerships where one partner may benefit, but the other may not.

Another example of mutual symbiosis is found in green plants called legumes. All green plants need nitrogen, but they cannot use it as a gas. They must get the nitrogen from the soil. Nitrogen compounds (nitrogen combined with other substances) are found in the soil. Legumes develop bumps called nodules on their roots. Inside the nodules are bacteria. These bacteria are capable of taking the nitrogen from the air and changing it into the compounds which the plants can use. These bacteria can do this only inside the plant roots, and the plant can only use the nitrogen after the bacteria have changed it. This relationship allows the plants to live in areas where the soil is nitrogen poor.

[1] "Partners," Nature and Science, Volume 4, No. 9, (Jan. 30, 1967), p. 8.

INFORMATION CARD

Measuring the Microclimate of a Habitat

To the Student:

With some of the following activities you will be asked to examine small areas around your school or home, such as a lawn, a tree, or a ditch. The scientific name for this kind of study is microclimatology. When a scientist studies a microclimate he examines in a small area such things as the weather conditions, soil, plant and animal life, and the ways in which all of these are interrelated (ecology).

With the following suggestions you will be able to carry out the same type of investigations. Most of the activities will require you to carefully collect data or information from which you can make some logical conclusions. Some of the best data you collect will come from using some simple devices that you can easily make yourself.

VOCABULARY

1. microclimatology: small scale climate studies
2. standardize: a basis for comparing like things
3. variations: changes
4. psychrometer: an instrument for measuring relative humidity
5. constricted: drawn together
6. vertically: up and down position
7. photosynthesis: process by which green plants produce food from sunlight, carbon dioxide and water

DATA CARD

Suggestions for Examining a Mini-Climate

TO MEASURE THE DIFFERENCES IN TEMPERATURE:

Materials:
- 4 thermometers (bare bulbs preferred)
- digging tool
- 4 cardboard tubes
- wooden stake (four feet)

To learn about outdoor temperatures, you must be able to read thermometers accurately. See your teacher for help. The thermometers used in this activity should have exposed bulbs. Weather thermometers usually do not have exposed bulbs, but can be used with some allowances.

Outdoor temperature activities will require that many thermometers be used at the same time. It is necessary to standardize them. This can be done by placing them all on a table with the scale up. After ten minutes, note the temperature readings. If some are higher, place a piece of tape showing -1, -2, -3, etc. on the thermometer. This will show the number of degrees to be subtracted in order to obtain standard readings. If the readings were lower, use +1, +2, +3, etc. This shows the number of degrees to be added.

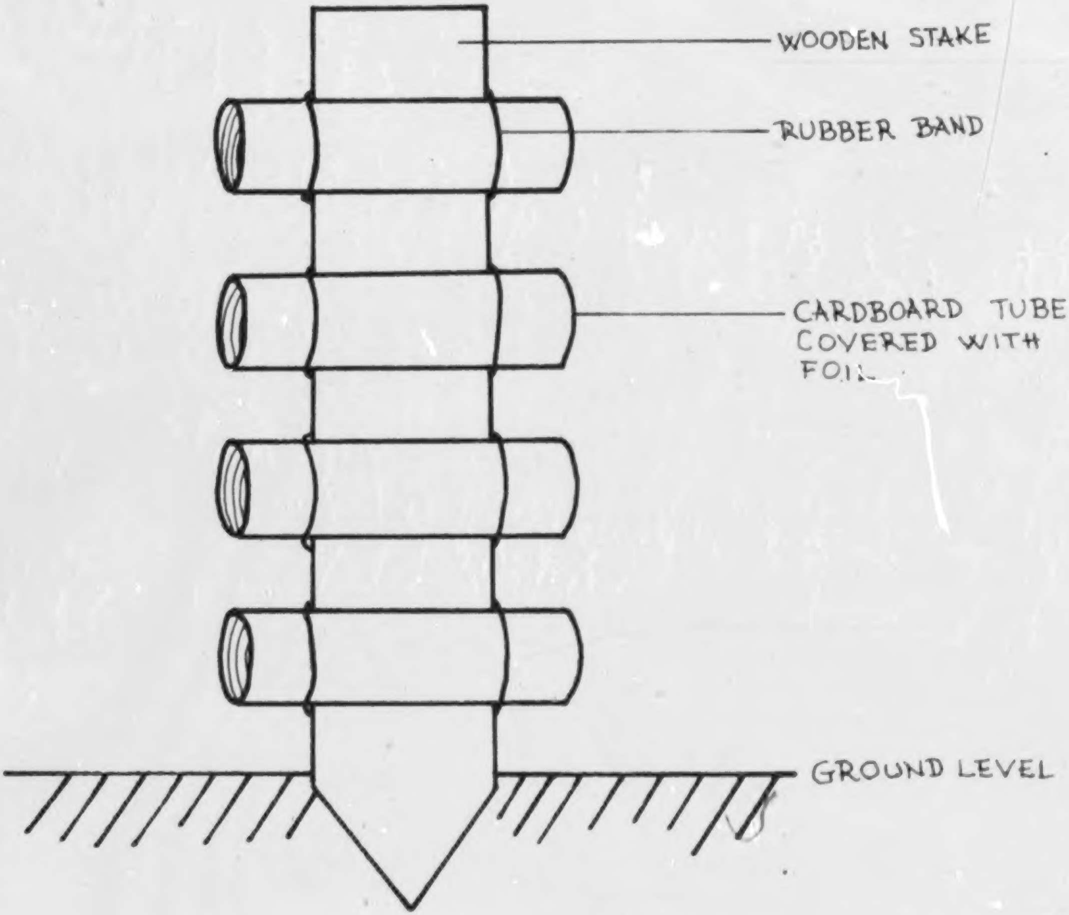
Once this is done, you are ready to proceed. It will be necessary to hold the thermometers steady at certain heights and to read all the temperatures at the same time. Because of this need, a thermometer stand will have to be constructed. You will need a board about four feet long with a sharpened end. You will also need four cardboard tubes (mailing tubes or the center cardboard cores of a paper towel roll will do) wrapped in aluminum foil. This will keep the sun from striking the thermometers or cardboard tubes directly. This causes variations in your results.

Attach the foil-covered tubes to the wooden stake with rubber bands at various distances along the stake. Drive the stake into the ground. It should stand by itself in an upright position. Adjust the tubes to the heights above the ground from which you wish to get temperature readings (see drawing). Insert your thermometers into the tubes. Wait ten minutes for the fluid in the thermometers to stop moving. Pull just enough of the thermometer out of the tube to get a reading. Do not expose the bulb to the sun's rays. Record your measurements.

Place a thermometer in a loose cardboard tube flat on the ground with the bulb up. Record the temperature after ten minutes. This will give you a reading at ground level.

To take a temperature reading below the surface of the ground, take a trowel, or some other digging tool. Make a slit in the soil with the blade. Pull the tool back. Slide the bulb of the thermometer about three centimeters into the slit. Slip the tool out. Close the soil against the thermometer. Read the thermometer only after the fluid stops moving by scraping away just enough soil to see the scale.

TO MEASURE TEMPERATURE DIFFERENCES (OF HEIGHTS ABOVE GROUND)


WOODEN STAKE
RUBBER BAND
CARDBOARD TUBES COVERED WITH FOIL
GROUND LEVEL

DATA CARD

Suggestions for Examining a Mini-Climate (Habitat)

TO MEASURE THE MOISTURE:

Materials:
hand drill
tape
an inch long wick
steel rod (about 12 inches long)
two bare bulb thermometers

In measuring the moisture in the soil, an easy scale to use with five degrees of moistness is:

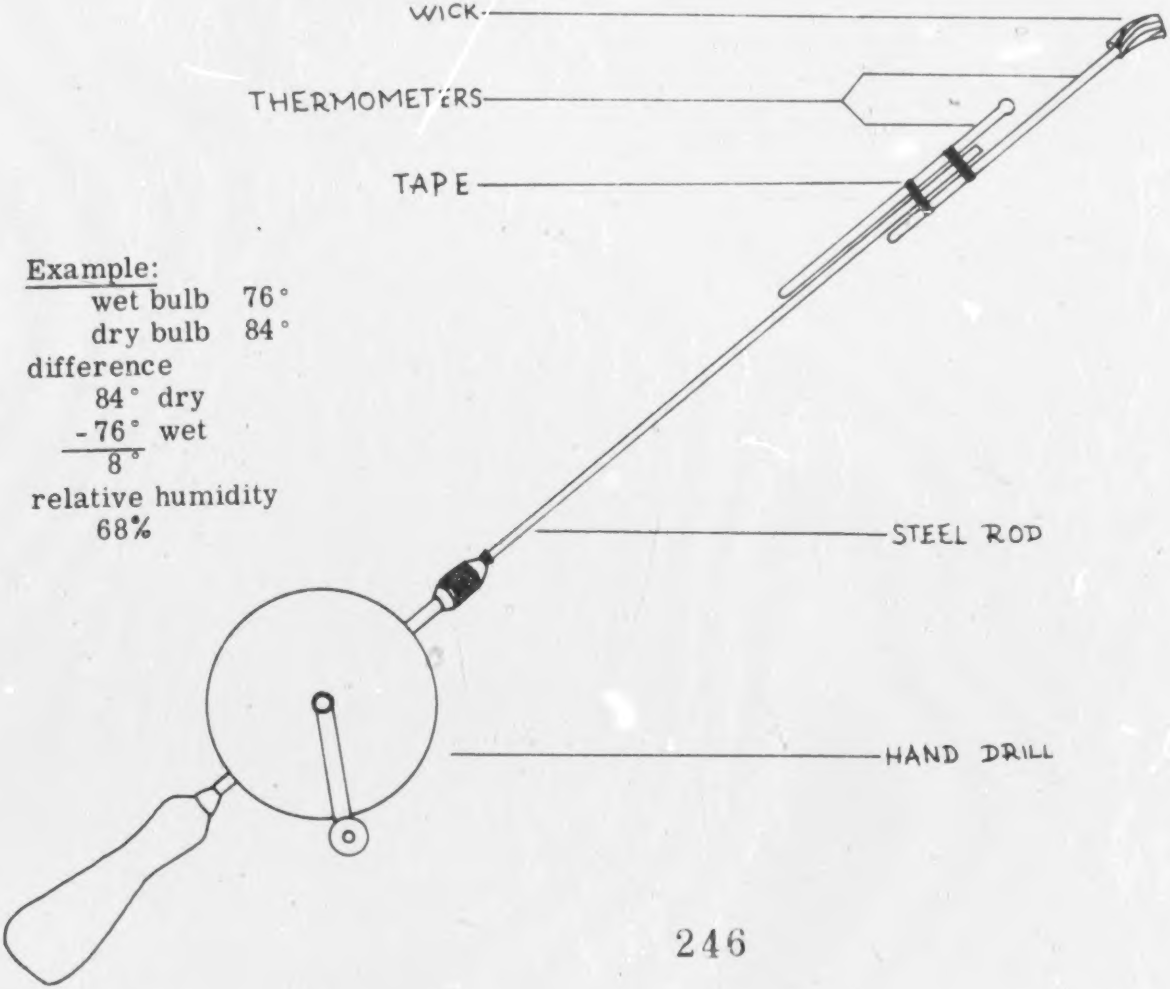
1. DRY — (falls apart and sifts between fingers)
2. SLIGHTLY MOIST — (appears moist, but does not stick together when squeezed)
3. MOIST — (sticks in a clump when squeezed)
4. VERY MOIST — (squeeze and the water is obvious)
5. WET — (water drips)

To measure moisture in the air (humidity) however, is a little more involved. When we measure humidity we talk in terms of "relative humidity." Relative humidity is the water vapor in the air compared to the total amount that the air could hold at that temperature. The relative humidity is expressed as a percentage.

Relative humidity can be measured by an instrument called a psychrometer. It sounds complicated. It consists of an appratus holding one wet and one dry thermometer. It also has a means of twirling or swinging them together. If a hand drill or a hand mixer are available to you, the thermometers can be attached to the shaft. You can twirl them mechanically (see drawing). The thermometers also can be attached to a round stick, such as a cut-off broomstick. They can be twirled between your hands. These devices work well in constricted areas such as under a bush or under a ledge.

Whichever device you select to work with, the procedure will be the same. First observe and record the temperature on both thermometers. Then moisten the wick with water. Place it securely around the bulb of one of the thermometers. This is your "wet" thermometer. Twirl both thermometers together with your apparatus for 30 seconds. Then, take the temperature readings again and record them.

You are now ready to calculate the relative humidity. Use the Percent of Relative Humidity chart. In order to find the correct percentage, locate the dry bulb reading on the side scale. Locate the difference between the wet bulb reading and the dry bulb reading on the top scale. Run your fingers along the column and the row until they meet. The number at the point of intersection of the two scales is the percentage of relative humidity.


WICK
THERMOMETERS
TAPE
STEEL ROD
HAND DRILL

Example:
wet bulb 76°
dry bulb 84°
difference
84° dry
$\underline{-76°}$ wet
8°
relative humidity
68%

PERCENT OF RELATIVE HUMIDITY--F°

Temp of Dry Bulb	*Difference in degrees between Dry Bulb and Wet Bulb*																		
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*
98	96	93	89	86	82	79	76	72	69	66	63	60	57	54	52	49	46	44	41
96	96	93	89	85	82	78	75	72	68	65	62	59	57	54	51	48	45	43	40
94	96	93	89	85	81	78	75	71	68	65	62	59	56	53	50	47	44	42	39
92	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43	40	38
90	96	92	88	84	81	77	74	70	67	63	60	57	54	51	48	45	42	39	36
88	96	92	88	84	80	77	73	69	66	63	59	56	53	50	47	44	41	38	35
86	96	92	88	84	80	76	72	69	65	62	58	55	52	49	45	42	39	36	33
84	96	92	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	35	32
82	96	91	87	83	79	75	71	67	64	60	56	53	49	46	43	40	36	33	30
80	96	91	87	83	79	74	70	66	63	59	55	52	48	45	41	38	35	31	28
78	95	91	86	82	78	74	70	66	62	58	54	50	47	43	40	36	33	30	26
76	95	91	86	82	78	73	69	65	61	57	53	49	45	42	38	34	31	28	24
74	95	90	86	81	77	72	68	64	60	56	52	48	44	40	36	33	29	26	22
72	95	90	85	80	76	71	67	63	58	54	50	46	42	38	34	31	27	23	20
70	95	90	85	80	75	71	66	62	57	53	49	44	40	36	32	28	24	21	17
68	95	90	84	79	75	70	65	60	56	51	47	43	38	34	30	26	22	18	15
66	95	89	84	78	74	69	64	59	54	50	45	41	36	32	28	23	20	16	12
64	94	89	83	78	73	68	63	58	53	48	43	39	34	30	25	21	17	13	9
62	94	88	83	77	72	67	61	56	51	46	41	37	32	27	23	18	14	10	5
60	94	88	82	77	71	65	60	55	50	44	39	34	29	25	20	15	11	6	2
58	94	88	82	76	70	64	59	53	48	42	37	31	26	22	17	12	7	2	
56	94	87	81	75	69	63	57	51	46	40	35	29	24	19	13	8	3		
54	93	87	80	74	68	61	55	49	43	38	32	26	21	15	10	5			
52	93	86	79	73	66	60	54	47	41	35	29	23	17	12	6				
50	93	86	79	72	65	59	52	45	38	32	26	20	14	8	2				
48	92	85	77	70	63	56	49	42	36	29	22	16	10	4					
46	92	84	77	69	62	54	47	40	33	26	19	12	6						
44	92	84	75	68	60	52	45	37	29	22	15	8							
42	91	83	74	66	58	50	42	34	26	18									
40	91	82	73	65	56	47	39	30	26										
38	91	82	72	64	56	46	38												
36	90	80	71	62	54	46													
34	89	79	69	62	54														
32	89	78	68	61	48														
30	88	76	66	56	47														
28	87	75	65	53	43														
26	86	73	63	50	38														
24	85	71	60	47															
23	85	70	58																
22	85	69																	
[illegible]	85																		

Couthman and others, Miniclimates. Minneapolis: Mine Publications, 1972, p. 81.

DATA CARD

Suggestions for Examining a Mini-Climate (Habitat)

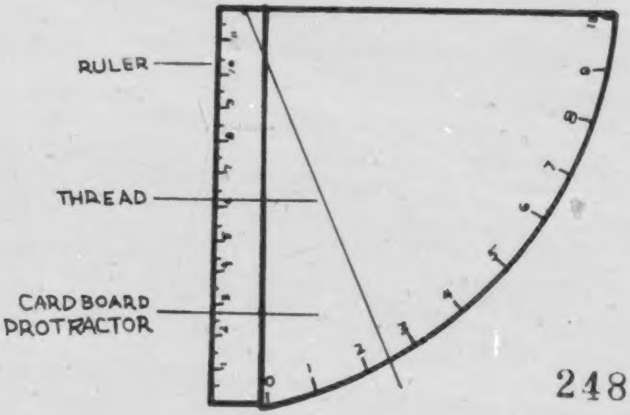
TO MEASURE THE WIND (VELOCITY):

Materials:		
	12 inch ruler	12 inch length of thread
	light oil (3-in-1)	tape
	12 inch square of rigid cardboard	

Attach a piece of thread about 12 inches long to the top end of a vertically-held ruler. Cut off any thread that hangs below the bottom end of the ruler. This is so it hangs freely and does not get hung up on the edge. When the wind blows the thread, the thread will make an angle with the ruler. This angle will vary with the strength of the wind. The angle may be measured by a cardboard protractor with equally spaced marks along the edge (see drawing). The marks could be numbered in order from 0 at the bottom and 10 at the top. Attach the protractor to the ruler with tape. When the wind blows the thread, the velocity could be expressed according to how high up on the protractor the thread reaches; mark one, mark two, mark three, etc.

If the thread curls and does not hang straight, it can be rubbed out straight with a small amount of light oil (3-in-1, cooking oil) on the fingers.

Wind direction can easily be determined. Use the direction the wind is blowing the thread and a magnetic compass.



DATA CARD

Suggestions for Examining a Mini-Climate (Habitat)

TO MEASURE LIGHT INTENSITY:

Materials:		
	12 inch ruler	a camera light meter
	masking tape	light gray construction paper (12" square)

The amount of sunlight is of great importance to plant and animal life. Plants require sunlight as a source on energy in order to produce plant food. The process by which green plants use sunlight to make plant food is called photosynthesis. Sunlight strongly affects the behavior of animals. Some animals are active in daylight and others become active only at night. Others find the time between day and night as most suitable for their activities.

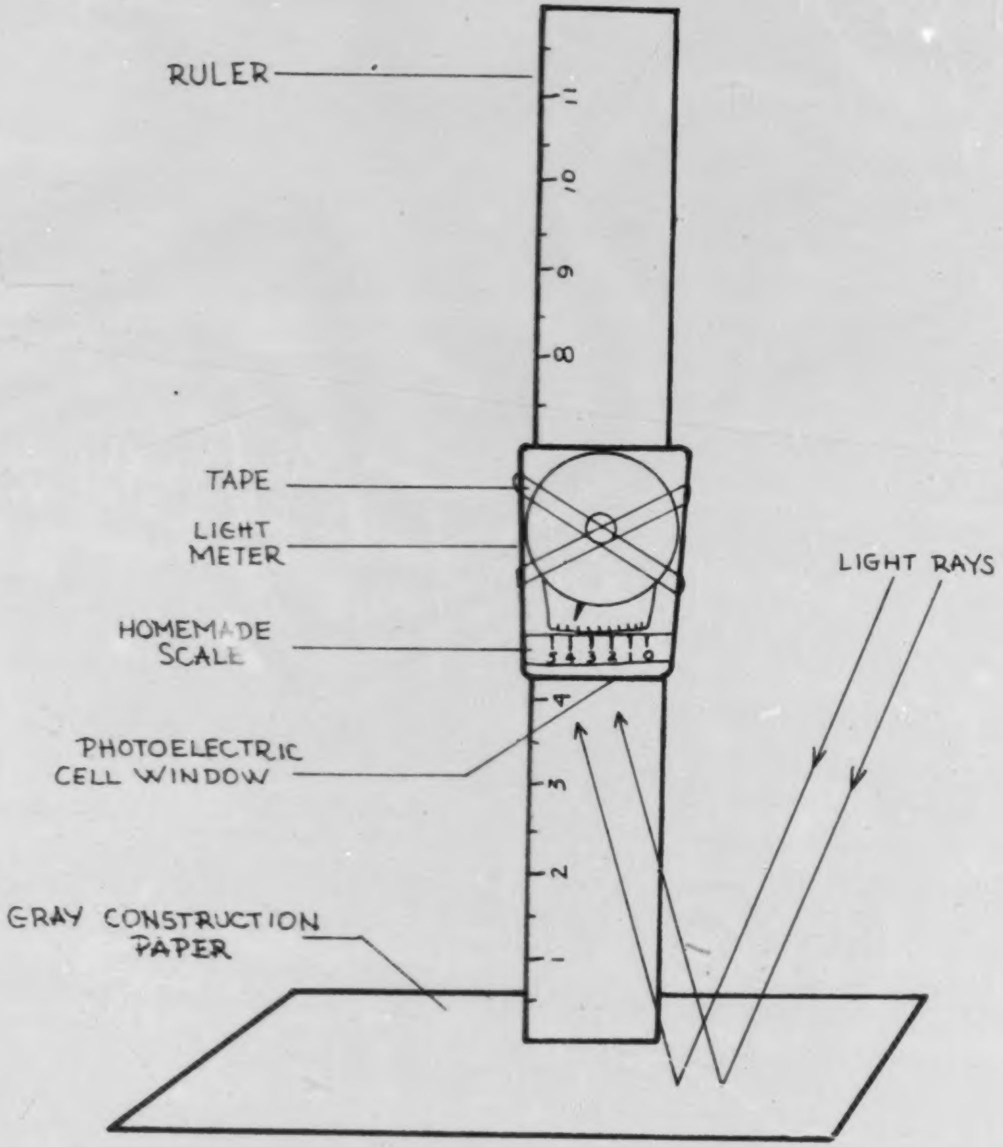
The device described below will give you the means to measure the intensity of the light striking the habitat.

Obtain a light meter. Caution must be taken. This is a sensitive instrument. Pointing it at the sun directly may damage it. Fasten the light meter to a 12-inch ruler with masking tape. The photoelectric cell of the meter should be at the 4-inch mark (see drawing).

On a small strip of paper, draw a scale from 0 to 5. Tape it to the light meter face (see drawing). Cut a 12-inch square piece of light gray colored construction paper.

When the sun is shining brightly, place the construction paper at the various locations. At the same time, read and record the intensity on your home-made scale. Hold the ruler with the meter in a vertical position. Be careful your shadow does not fall on the paper.

This activity measures the amount of light reflected from the construction paper. If you wish to measure the light intensity as light is reflected from different surfaces such as the lawn, bare ground, shrubs, asphalt, remove the construction paper. Place the end of the ruler with the light meter directly on the surface you want to examine.


RULER
11
10
9
8
TAPE
LIGHT METER
HOMEMADE SCALE
5 4 3 2 1 0
LIGHT RAYS
PHOTOELECTRIC CELL WINDOW
4
3
2
1
GRAY CONSTRUCTION PAPER

the problem:

How are the activities of man changing the ecosystems (E-ko-sis-tems) around you? (An ecosystem is a community that includes both living and non-living things.)

clues for you:

Read the information card, Ecosystems. Be sure you understand what an ecosystem is. Identify some local ecosystems. Pick one to study.

Make a thorough study of that ecosystem. Make a chart showing all the members of the ecosystem, living and non-living. Show how these members are inter-related. If one member changes, how does it affect the others? Show the ways the activities of man are affecting the ecosystem.

Choose one of the members of the ecosystem. Write a story through the eyes of that member. Tell what is happening to the ecosystem. Predict what the ecosystem will be like in the future. Record your story for the class.

Materials:
information cards, Ecosystems (55-1), Great Barrier Reef (55-3) and Brevard's Oyster Industry (36-4)
chart paper, pens

other ways to look at it:

.. Is the ecosystem you studied protected? Are new laws needed? Who should be responsible for protecting it?

.. Look at your chart. Predict what would happen if one of the living things disappeared. If one of the non-living factors changed greatly?

.. Make a play from your story. Assign parts.

.. Read The Great Barrier Reef. List the biotic and abiotic features of this system. What do you think is causing the destruction of the reef? Is anything being done to protect the reef? What should be done?

.. Read about the oyster industry in Brevard County (36-4). What abiotic factors are important in oyster production? How are man's activities threatening the natural balance in this ecosystem?

.. Are your local ecosystems endangered? Keep a file of newspaper articles that show changes in the natural balance of ecosystems.

what did you discover?

Make a display. Show the ways the activities of man are affecting the ecosystem you studied.

ECOSYSTEMS ECOSYSTEMS ECOSYSTEMS

ECOSYSTEMS ECOSYSTEMS ECOSYSTEMS

Ecosystems

Living things exist in communities. We call these communities biotic, meaning living. We can study these living things and their relationship to one another. But every biotic, or living, community exists within an abiotic, or non-living one. When we relate the non-living environment to the living community, we are studying an ecosystem. An ecosystem includes all of the relationships--of each and every part, living and non-living. To study an ecosystem, one must measure the abiotic factors, such as wind speed and direction, moisture, temperature and the amount of sunlight. These factors must then be related to the living community. The ecologist is also interested in what effect living things have on the non-living environment. For example, what effect does an increase in water hyacinths have on the speed of water?

Ecosystems do not exist separate from everything else: ecosystems are linked to the ecosystems around them. A group of ecosystems having similiar amounts of sunlight, rainfall, and related temperature, plants and animals form a biome. You may wish to read the information card on biomes.

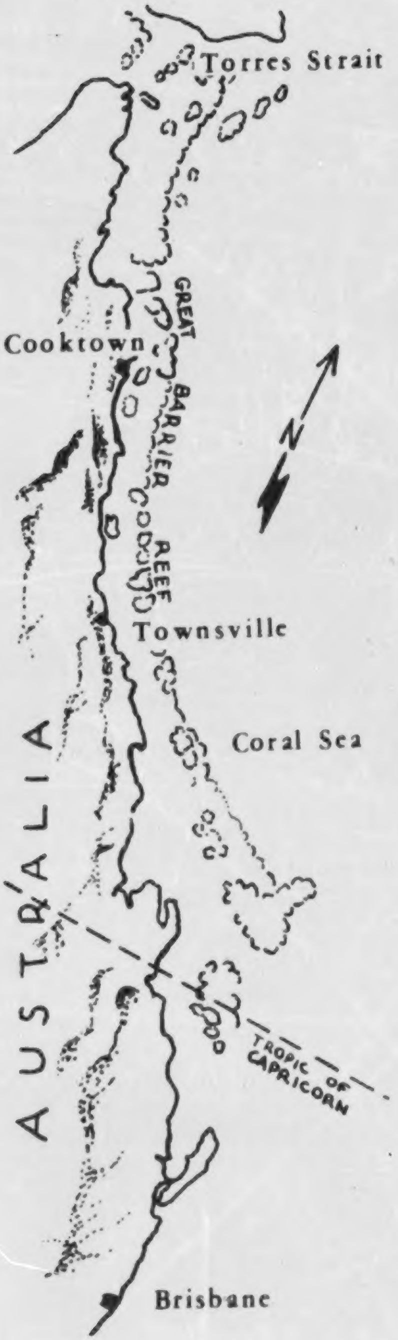
Ecosystems which are found in this area of Florida include: pine flatwoods, hammocks, fresh water marshes, sand pine scrub, salt marshes, fresh water canals, beach dunes, oceanic regions, mangrove swamp, estuaries and lagoons, inlets and cities. Your teacher has additional information on these ecosystems on a card, "Biotic Communities in Brevard County."

Reference: --High School Biology, BSCS Green Version, Second Edition. Chicago: Rand McNally and Company, 1968.

Ecosystems

VOCABULARY

1. biotic: living
2. abiotic: non-living
3. ecosystems: the entire pattern of relationships between biotic and abiotic communities in one area
4. linked: connected
5. biome: all ecosystems on earth, inter-connected



THE GREAT BARRIER REEF

AN ECOSYSTEM IN TROUBLE

The largest animal-made structure on Earth is the Great Barrier Reef. It runs for 1250 miles off the northern coast of Australia (see map). This reef has been built up over a period of a million years. It represents a delicately balanced ecosystem. Now, the Great Barrier Reef is in trouble. See if you can understand why.

Coral reefs provide a home for many varieties of animals. A chunk of coral the size of an automobile may have fifty different kinds of fish living around it. Coral reefs also protect inland areas from the waves. They act as breakers.

The first link in this ecosystem is the tiny coral animal. Coral reefs are really formed from skeletons of millions of animals -- coral polyps. The polyps, or individuals, are bound together into colonies. These colonies take calcium from seawater. They change it into the limestone which forms the reef. The reef grows in all directions. Each new generation builds on top of the last. The coral animals use these skeletons as their home. They retreat into them in times of danger. Coral thrives in warm, clear, shallow water. It filters its food from the water that passes over it.

In the early 1960's scientists began to notice the destruction of the Great Barrier Reef from Cooktown, southward to Townsville. The main agent of destruction is the crown-of-thorns starfish, a seventeen-armed menace. It is dangerous to both man and coral.

The crown-of-thorns is a natural enemy of the coral. When the coral polyp is attacked, the animal withdraws into its cup of limestone. The starfish, however, pushes its stomach through its mouth and into the polyp's cavern. The polyp is surrounded. The starfish uses its digestive juices to digest the coral animal in its own home. Once the starfishes have eaten all the coral animals in one area, they move on. Without the coral to maintain the reef, the waves will tear into it. Eventually, they will destroy the reef. Normally, the crown-of-thorns is kept in check by its enemies. Its enemies include the giant triton, the giant clam, and the coral itself. The giant triton attacks and kills at least one adult crown-of-thorns starfish a week. It eats even more immature ones. The giant clam feeds on many small organisms. Its food includes the eggs and larvae of the starfish. The coral also captures and feeds upon the larvae of the starfish.

In recent years, several things have happened to disturb this delicate balance that makes up the ecosystem. The predators, or enemies, of the starfish have been reduced in many ways. The giant triton is being taken from the water in great numbers by amateur and commercial shell collectors. The giant clam is considered a delicacy. It is hunted by fishermen from as far away as China. The coral itself has been destroyed by the dredging of ship channels, and blasting for oil. Pollution from cities and farmlands also destroys it.

Scientists are not sure which event is responsible for the increase in the crown-of-thorns starfish. Perhaps it is a combination of things. Scientists have also noticed the destruction of coral reefs in other parts of the Pacific due to the crown-of-thorns.

Resources:

Abbey, Edward, "Man and the Great Reef," Audubon, January 1972.

The Great Barrier Reef

VOCABULARY

1. ecosystem: the entire pattern of relationships between living and non-living members of a community.
2. polyps: living parts of a coral
3. calcium: an element found in chalk, milk, and limestone
4. limestone: a sedimentary rock made up of the shells of small animals
5. thrives: to increase quickly
6. menace: to cause injury
7. triton: an animal with a large, colorful coiled shell, like a conch shell
8. immature: young, not fully grown

the problem:

How has man affected this biome?

clues for you:

Read the information card Biomes. What biome do you live in? Does it fit the description given? Observe the plants and animals in your area. Do they fit the description given?

. For a period of six weeks, continue to make observations in your area. Read the newspaper. Collect information on all the ways that man is changing the character of your biome.

Present your information to the rest of the class. Include evidence you collected. Predict how these changes will affect the plant and animal life of the area. As a class, discuss how man can live in a biome without changing it.

Materials:
information cards, Biome (56-1) and
and The Biosphere (56-6)
newspaper articles, magazines
glue, scissors

other ways to look at it:

.. Write to friends in other biomes. If you don't know anyone in another biome, this would be a good time for a pen pal. Ask your friends to send pictures of plants and animals in that biome. Ask them to collect information on the ways man is changing the biome.

.. Your biome is part of the larger biosphere. Read the information card, The Biosphere. Collect newspaper articles and magazine pictures. Make a collage showing the problems man has caused in the biosphere.

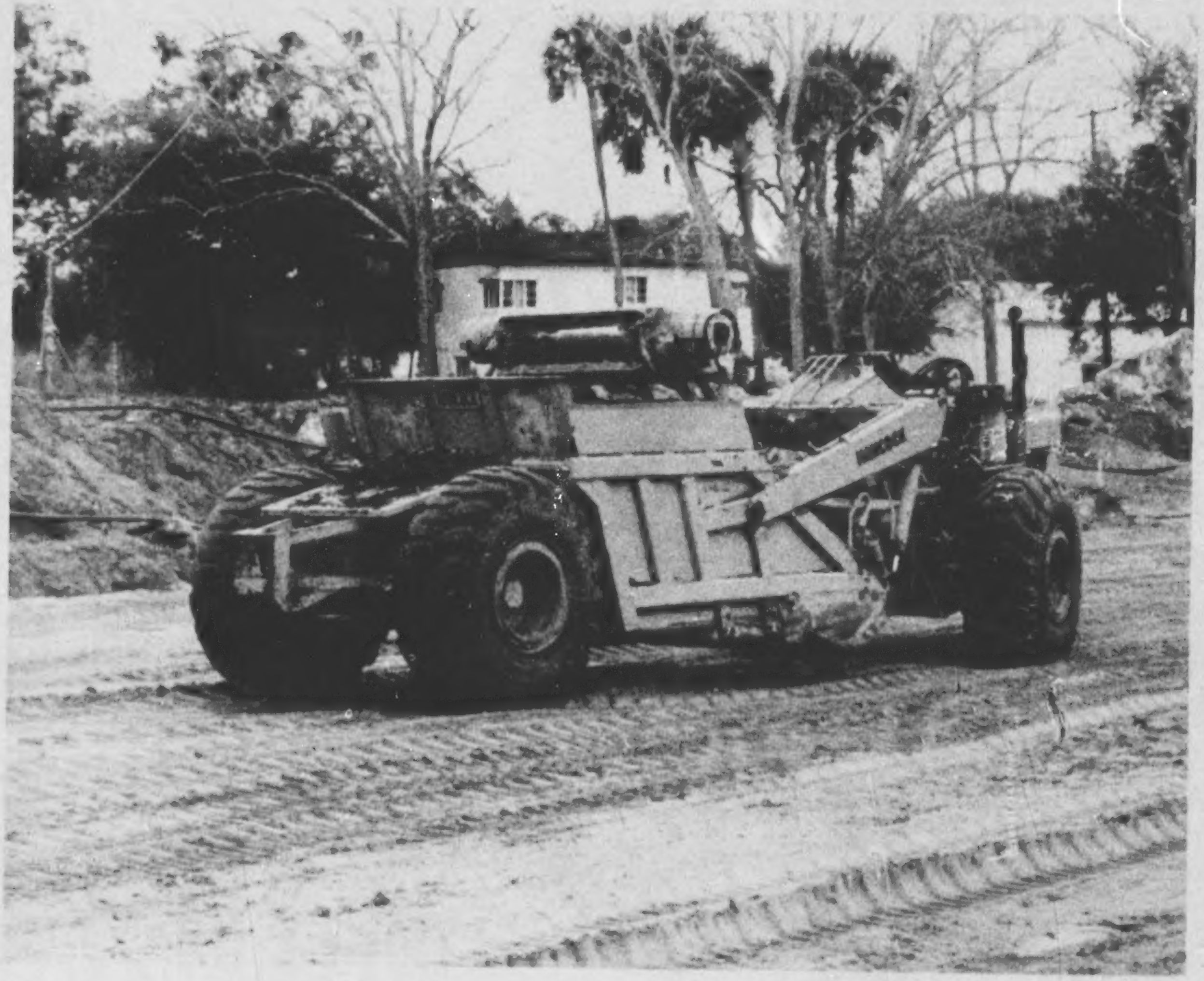
.. What is the source of energy for all the biosphere? What activities of man are affecting the amount of sunlight that reaches you? Read about the ozone layer and changes in the amount of carbon dioxide in the atmosphere.

.. What local happenings may be endangering the biosphere? Keep a scrapbook of local events that change the biosphere. Discuss them in class.

what did you discover?

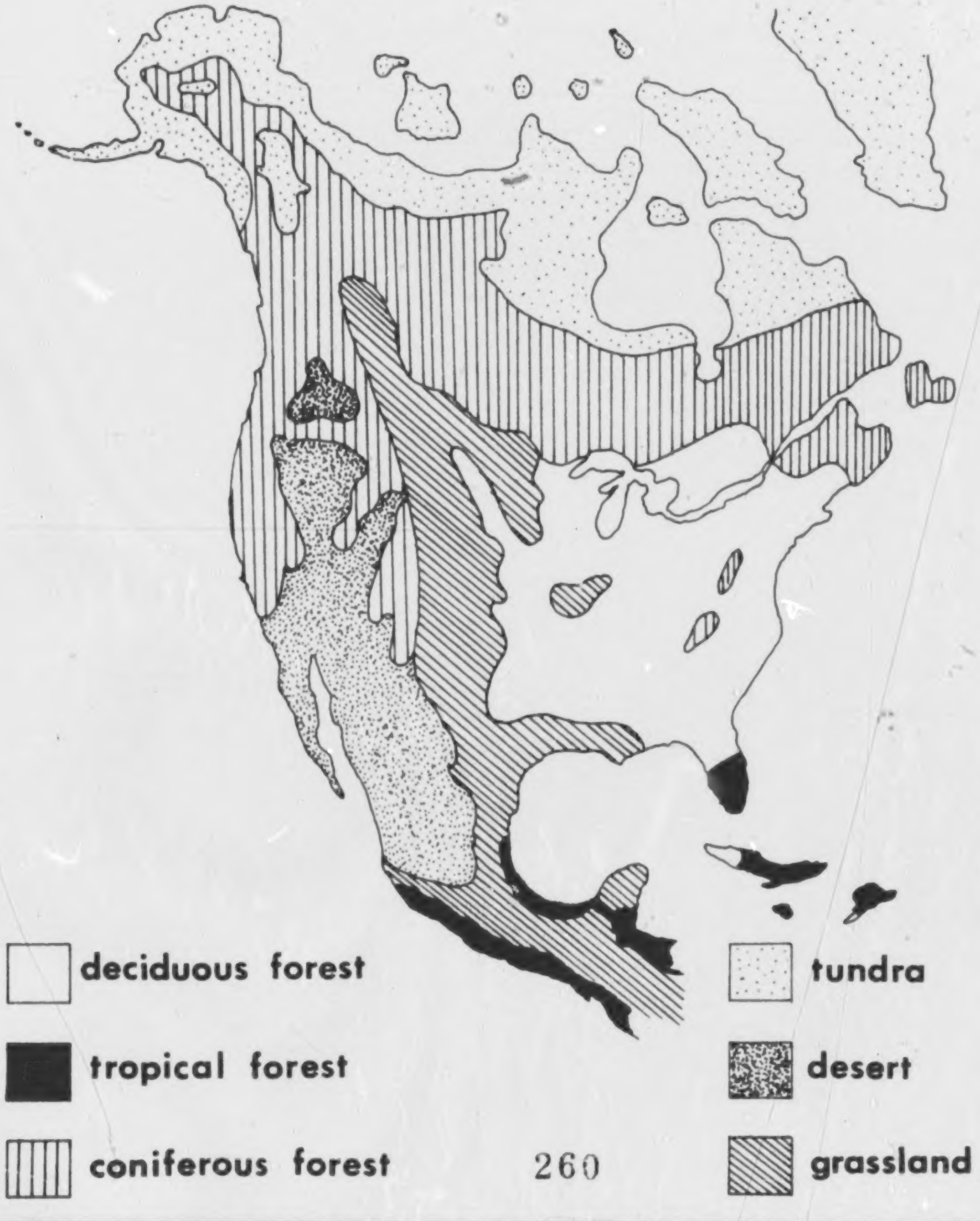
Make a chart. Show at least three ways man is changing the character of the biome in which you live.

BIOSPHERE . CIRCLE OF LIFE . BIOSPHERE .



CIRCLE OF LIFE . BIOSPHERE . CIRCLE OF LIFE .

Biomes of the United States


□ deciduous forest
■ tropical forest
▥ coniferous forest
⛆ tundra
▩ desert
▧ grassland

INFORMATION CARD

Biomes

If you have traveled much, you may have noticed that you will not find the same plants and animals everywhere. Even if you haven't traveled much, you wouldn't expect to find a polar bear in Florida!

Scientists study the plants and animals that live in different parts of the world. They have a name for any large area that has similar plants and animals as well as similar climate and soil. These areas are called biomes (By-omes). The map on this card shows the six major biomes of North America. Find the biome you live in.

Slowly, over many hundreds of years, each biome built up its special kind of soil. It also developed special kinds of plants and animals. The kind of soil depended on the kinds of rock that went into making it (parent materials). The amount of rainfall and sunlight helped decide how fast the rock was turned into soil. Sun, water, and temperature played a big part in which plants would survive. All of these things determined which animals could live there.

A biome is named for the dominant, or strongest, plant life. Dominant plants are those which have been able to adapt best to the conditions of the biome. Sometimes the dominant plant in the biome is destroyed. Man may cut the trees, or fires may destroy the plant life. When this happens, new and temporary plants grow there. Eventually they are replaced by stronger plants. This process is called succession. Succession continues until the dominant plant of the biome grows. When this happens, scientists say the area has reached a climax.

The dominant plant is determined by:

light and temperature	soil conditions
rainfall and evaporation	surface form (mountains, lakes, etc.)

The only tropical climate in our country is found at the southern tip of Florida. The plants and animals living here are those best suited (or adapted) to live in this climate. This biome is called the TROPICAL FOREST BIOME.

The tropical forest biome is marked by a hot, wet season, from May to November. Then as many as sixty inches of rain may fall. A second cooler, dry season occurs from December to April. Then the temperature averages about 70 degrees. Even during the dry season, the climate stays warm and moist. Soem of the plants that are fitted to this climate include the coconut palms, mangroves, and many air plants. This area is famous for its big birds, including roseate spoonbills, egrets, heron, and ibis. Other unusual animals include alligators, water snakes, otters, sea cows (manatees) and a few bears.

The DECIDUOUS FOREST BIOME covers most of the eastern half of the nation. Here, the seasons change from summer heat to winter cold. Rainfall averages between 30 to 40 inches a year. The dominant plant is deciduous trees. "Deciduous" means "to fall." Deciduous trees have leaves that fall off in winter. Examples of the trees in this biome are maples, oaks, beeches, elms, ashes, and hickories. Many of the trees that once covered this area have been cut down for lumber. They were also cut to make room for cities and farms. Animals of this biome include squirrels, chipmunks, raccoons, foxes, deer, some bears, woodpeckers, and jays. There are several kinds of hawks and owls and great numbers of smaller creatures that live in the forest floor.

Further north, the deciduous forests change into the great coniferous forests of Canada. Coniferous trees are sometimes called evergreens. They do not loose their leaves. As you may have guessed, the name of this biome is the CONIFEROUS FOREST BIOME. Spruces and other cone-bearing evergreens are its main trees. This biome has cool summers with plenty of rain. The winter is very cold. Deep snow covers the ground as well as many of the small trees. Moose, snowshoe rabbits, lynx, wolverines, spruce grouse, red crossbills, Canada jays, and great horned owls are some of the animals one might discover.

Finally, as you keep going north, you reach the TUNDRA BIOME. Tundra is bare, rocky country. The climate is so cold and windy that no forests are found here. Most of the plants would be grasses, sedges, and reindeer moss. Year-round animals would include lemmings, arctic foxes, arctic grizzly bear, ermine, musk ox, and some wolves.

During the short summer season the sun shines 24 hours a day. Then the climate is right for other animals to live there too. Great herds of caribou come from the south to feed on the low plants. Millions of birds come from the south to nest and raise their families. As the days shorten and the long dark winter approaches, many of the animals leave for warmer and more sheltered places.

Flat, open country covers hundreds of square miles from the Mississippi River to the Rocky Mountains. This makes up a GRASSLANDS BIOME. The summers are very warm. Because of its low rainfall and high evaporation, it has few trees. Today, grain crops cover the prairies. They were once covered with wild grasses and flowering plants. Cows, sheep, and other domesticated animals have taken the place of wild bison herds. Some wild animals that can still be found in the area. They include ground squirrels, gophers, jack rabbits, bagers, coyotes, meadowlarks, burrowing owls, prairie falcons. You can also see an occasional flock of prairie chickens.

The last of the six major biomes is the DESERT BIOMES. It is hot and dry. Some deserts have less than five inches of rain a year. The humidity is low. During the day the blazing sun beats down. Desert nights are often very cold. Only plants and animals that have become adapted to life under these conditions can live here.

There is little water in desert soil. Because of this, plants grow far apart. Most of the plants have long roots that spread way out near the top of the ground. This helps them get all the water they can. They may have thick skins, and few or no leaves. This helps prevent evaporation.

Very few large animals live in the desert. Some small ones include kangaroo and pack rats, peccaries, spotted skunks, gila monster, cactus wrens, road runners, turkey vultures, and several kinds of owls. Lots of insects and invertebrates live in the desert, but they come out only at night to feed.

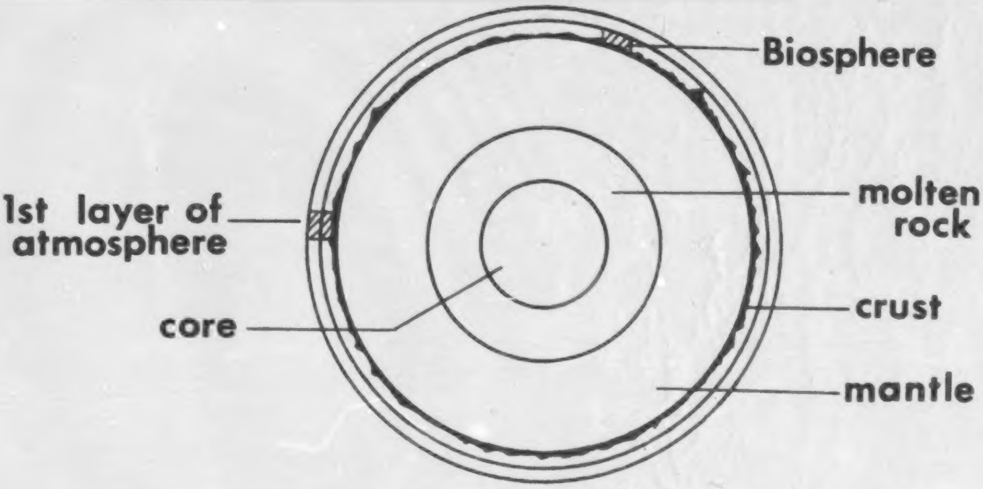
Reference:
Miller, Shirley. The Story of Ecology. New York: National Audubon Society.
Sharing the Earth. Scholastic Earth Corps Ecology/Conservation Book 3.
New York: Scholastic Book Services, 1971.

Biomes

VOCABULARY

1. dominant: most important
2. succession: coming one after another in order
3. climax: the final stage when a plant-animal community becomes stable
4. deciduous: trees which shed their leaves each year
5. coniferous: evergreen trees or cone-bearing trees
6. sedges: a small grasslike plant
7. peccaries: a type of wild pig

The Biosphere



Scientists divide the earth into different layers. The drawing shows some of these. Ecologists study life in its natural surroundings. They are interested in a very special layer of earth. They call it the BIOSPHERE. (BY-ose-fear). BIOS means life, and SPHERE is a round-shaped solid (like the earth). The biosphere is the area of the earth that supports life. It consists of all living things. It also includes the water, air, soil, and other matter surrounding them. Part of the biosphere is a layer of land and water. Part is a layer of air. The biosphere reaches as deep as the deepest oceans. It goes as high as the wind carries seeds, spores and pollen. The biosphere is thin when compared to the earth's other layers. This thin layer is "home" for more than one-and-a-half million kinds of plants and animals.

Evidence from fossils shows there has been a biosphere for at least 3,000,000,000 (three billion) years. Man has been a strand in the web of life for not much more than 1,000,000 (one million) years. In other words, the biosphere has been around 3,000 times longer than man.

At first, man had little effect on the web of life. Gradually, he learned to use sources of energy outside his own body. His population increased. Today, he has in his control enormous amounts of energy. With these, he changes the face of the earth. He also tears apart many sections of the web of life. Some activities of man present great problems for the future of all the biosphere.

-- Sharing the Earth, New York:
Scholastic Earth Corps, 1972.

Questions for Thought

1. What are the limits of the biosphere?
2. How old is it?
3. How does man relate to the biosphere?

VOCABULARY

1. strand: one thread of something
2. spores: the seeds of certain types of plants
3. enormous: very large amounts

the problem:

What changes cause a species to become extinct?

clues for you:

Look up the word extinct. List several animals that have become extinct. List reasons for their disappearance.

Many living things are in danger of becoming extinct. We say they are endangered. Research at least one plant or animal that is endangered. Write a short report telling why this animal or plant is endangered. Tell also if anything is being done to prevent its extinction. List the steps necessary to prevent this animal from becoming extinct.

Find a picture of this animal. Decoupage the picture of the animal on one side of a piece of wood. On the other side, add a short report on the animal.

Materials:
information cards, The Survivors (57-1), and The Brown Pelican (49-5) reprint, "Florida's Endangered Dozen"
wood, glue, picture of endangered animal

other ways to look at it:

.. Study one animal in Florida that is endangered. The resources listed below should help you. List the reasons each animal is becoming extinct. Is anyone doing anything to prevent this animal's disappearance?

.. Why should you be concerned about the disappearance of the alligator?

.. Collect pictures of endangered animals. Make a book about them. Be sure to include information about where they are found, their habits, and why they are becoming scarce.

.. The Department of the Interior publishes a list of endangered species. Write for it.

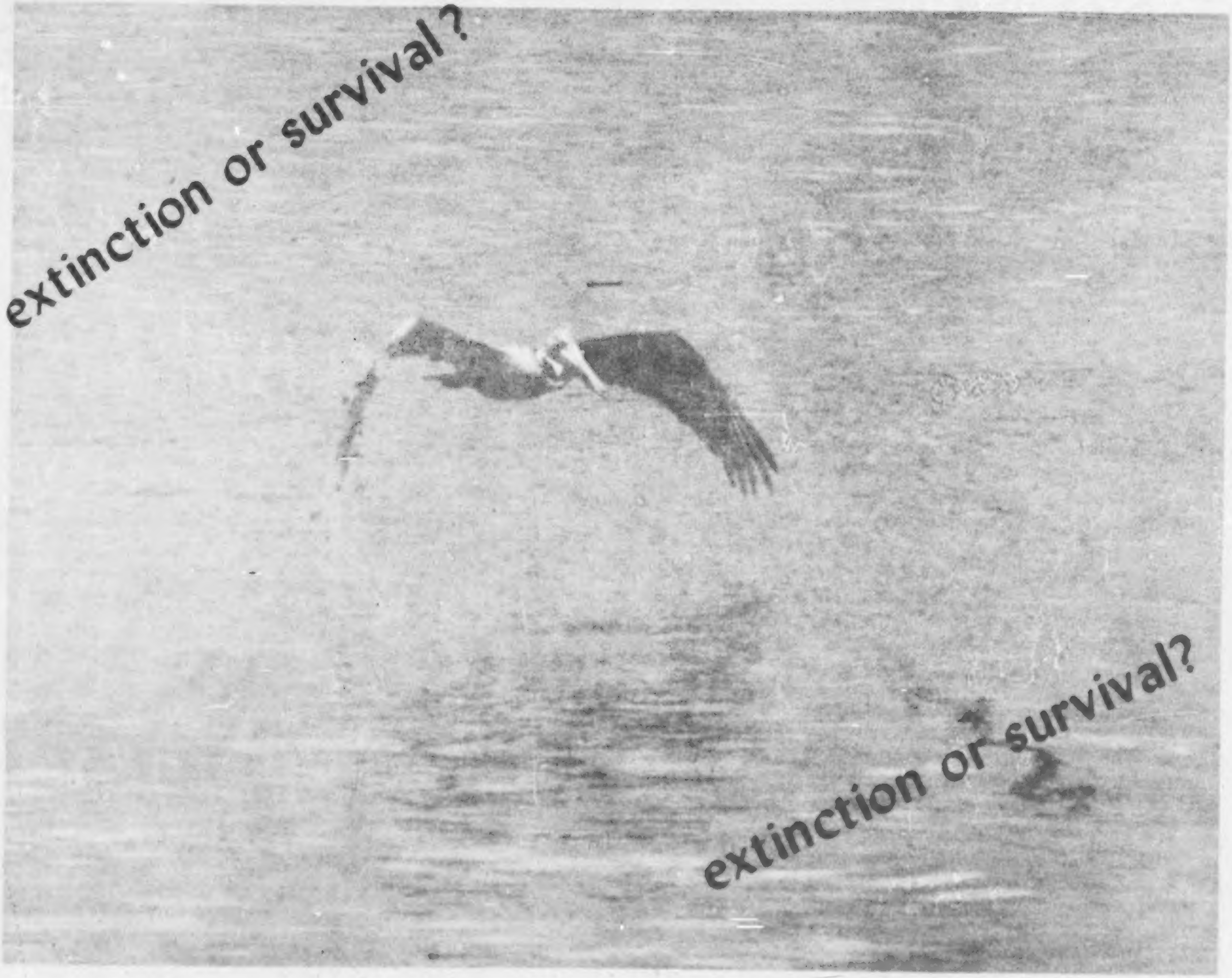
.. Research one extinct animal. Find out why it disappeared.

.. Discuss: can man and animals share the same space? What animals are most susceptible to the crush of civilization?

what did you discover?

Present to the class your report on one endangered animal. Be sure to give information about the animal's habitat, habits, and reasons for its being endangered.

Can this animal survive? Can this animal survive?


extinction or survival?
extinction or survival?

Can this animal survive? Can this animal survive?

INFORMATION CARD

The Survivors

Nature has created 100 million different kinds of creatures over the ages. Of these, 98 million are now extinct. Of the 2 million that remain, many are now rare and close to extinction. People who have never seen the desert addax, or the great Indian rhino, have little feeling for the possible extinction of these animals. These creatures are part of nature's experiments with life. They show the animals' remarkable adaptations to changing ways of life. Animals have been able to adapt to the changing climates and the ice ages. They have adapted to shifting desert sands, and the receding seas -- but not to man. The blue whale, for instance, is now endangered. No one knows for sure how many are left in the oceans of the world. Man has nearly whaled it out of existence. This is a sad fate for one of the largest creatures that ever lived.

The addax is a true creature of the desert. It gets water from the desert plants that make up its diet. Nomadic tribesmen still hunt the addax for food but the supply is dwindling. The addax has found its last refuge in the western Sahara. This is 193,000 square miles of waterless wilderness. Here is another example of an animal that took millions of years to create. It has taken only decades to destroy.

The bird is the symbol of freedom. It flies through the air in patterns very distant from man. Unfortunately, the bird must return to the earth. Here is where the trouble begins. The bird is hunted by man for food or for trophies. It is poisoned by man's pesticides. Birds have been made homeless by the cutting of trees and the plowing of fields. The bird is no longer free. Since 1600, 94 different kinds of birds have been erased from the living record.

The California Condor once soared over most of the American West. Lewis and Clark saw its nine-foot wing span over territory they explored. The condor hunted from Arizona to the Northern Rockies. In turn, it was hunted by man. Today there are only 42 remaining. The state of California has made killing the condor a felony. Still the giant is losing its battle with man.

The bald eagle is our national symbol. Even here, the bald eagle has been losing the battle for survival. It is hunted as a prize trophy. Eagles have been poisoned by agricultural chemicals which weaken the egg shells. The bald eagle has found a last refuge in the Everglades of Florida. The eagle is now protected only after the damage has been done.

The gorilla lives in the mountains and in lowland swamps. He is a vegetarian in the wild. He eats leaves, wild berries, and bamboo shoots. He nests on the ground or in trees. To cross bodies of water, he requires fallen trees. Some gorillas grow to a height of 5 feet and weigh 400 pounds. Only one-half of the gorillas born ever reach adulthood. His greatest enemies are the appetite of the tribesmen who hunt him. Man's agriculture has also destroyed the jungles the gorilla calls home. The lowland and mountain gorillas are now limited to the Congo. They are listed as endangered on the world's list of animals.

In the highlands of Asia lives a giant cat. Through the ice ages and a modern war, the cat survived. These powerful hunters survived all that happened to them. This powerful cat was the tiger. Today, there are seven races of tiger remaining on the earth. All but the Bengal tiger are on the endangered list. The Bengal tiger is headed for the same fate as his cousins.

Three factors threaten these animals. The pressure of man's presence reduces the wild areas. Man builds shopping centers, industries, housing areas, and farms in areas where animals once roamed.

The largest of all tigers is the Siberian tiger. It once roamed all over Siberia. Now the only stable population is in some of the remote mountain areas of Korea. In Russia the tiger is now protected by law in game farms. The Soviet Union is trying to raise populations of wild boar to serve as prey for these tigers. This will save the cattle of the farmers. There are only about 100 of these animals left. The population seems to be declining.

Man protects his animals from the animals of the wilds. The predator requires prey. When the deer and antelope dwindle, so must the tiger.

Some creatures are tied to living in a certain habitat. They cannot escape from these places and adapt to a different environment. Dozens of creatures were intended to live in the swamp. The Everglades National Park is a sanctuary for many of these. They include the great white heron, the bald eagle, the sea cow (manatee), and the American alligator. Hunters looking for hides for shoes and handbags have changed the alligator population from millions to only 20,000.

--- John Barbour-TODAY Newspaper,
Sunday, July 29, 1973.

VOCABULARY

1. extinct: no longer alive
2. addax: a large pale-colored antelope
3. adaptations: changes to fit the environment
4. receding: goes back
5. decades: 10 year periods
6. felony: a bad crime
7. vegetarian: one who eats only vegetables
8. stable: fixed, not changing
9. sanctuary: a place of protection

GLOSSARY

A abandon — leave something alone (24-2)
abandoned — left behind (49-4)
abiotic — non-living (55-1)
abundant — existing in great numbers (49-4)
accordingly — as a result of, to agree with something else (3-2)
adaptations — changing to fit the environment (57-1)
adapted — fitted, or adjusted to (20-1)
addax — a large pale-colored antelope (57-1)
adjusting — fitting things to one another (35-1)
aeration — adding air (15-2) (37-6)
aerosols — very fine spray (39)
alternatives — another choice (42-1)
appliances — household machines such as washer, diswasher (35-1)
aquatic — having to do with water (19)
aquifer — underground layer of water (34-2)
archeologist — scientist who studies early forms of life (2-1)
artifacts — an object made by man for future use (2-1)
authority — someone in charge (38-3)
awls — a tool for making small holes (2-1)

B bacteria — microscopic things (37-1)
biocides — a substance which destroys life (49-5)
biome — all ecosystems on earth, inter-connected (55-1) (56-2)
biotic — living (55-1)
biotic potential — the ability of an animal or plant to reproduce in the environment (24-1)
bison — a buffalo (2-1)
bland — tasteless (3-1)
bounty — a reward paid for killing certain animals (53-3)

C calcium — an element found in chalk, milk, and limestone (55-3)
carbon dioxide (CO_2) — gas found in the air (39)
carbon monoxide (CO) — pollutant formed when fuels burn (40-1)
carnivores — meat-eaters (51-1)
catalyst — a substance which speeds up a chemical reaction between other substances (42-4)
chambers — compartments, sections (42-2
chlorine — an element, a yellow gas with a very strong odor (37-5)
cinquain — special form of poetry (44)
climax — the final stage when a plant/animal community becomes stable (56-2)
coagulation — to drive together, clot (34-1)
combustion — the process of burning (42-1)
communities — groups of animals or plants living together (20-1)
conducted — held or guided (49-5)
coniferous — evergreen trees, or trees with cones (56-3)
consequences — results (3-1)
constant — always there (37-1)
constricted — drawn together (54-9)
consumed — used up (27-1) (45)
consumers — animals that use up food (51-1)
contaminated — unclean, or not pure (34-1)
converter — change to something else (42-1)
cooperation — everyone helping (35-1)
crisis — very serious problem that must be solved immediately (37-1)
cypress knee — the roots of a cypress tree which stick up out of the water or the ground (2-2)

D decades — 10-year period (57-1)
deciduous — trees that shed their leaves each year (56-3)
decomposers — animals which break down things into smaller parts (37-1) (51-1)

D dehydration — removal of water (3-2)
desalination — to take salt out of water (33-1)
Dickinson, Jonathan — an Englishman who was shipwrecked at Jupiter Inlet in 1696 on his way from Jamaica to Philadelphia (2-1)
disinfect — kill germs (34-1)
distilling — changing from a liquid to a gas by heating and then back to a liquid by cooling (33-1)
domesticated — tame (53-3)
dominant — strongest (56-2)
drastic — acting violently (57-1)
drought — dry spell (no rain) (26-2)
duff — partially decayed organic matter (16-1)

E economic — having to do with money (3-1)
ecosystem — the entire pattern of relationships between biotic and abiotic communities in one area (55-1) (55-3)
effluent — material flowing out (36-2)
emissions — substances which are given off (42-1)
enormous — very large amounts (30-1) (56-7)
entrails — intestines of an animal (2-1)
environment — everything that is around you, your surroundings (1)
environmentalists — people who study the environment, and are interested in protecting it (27-1)
EPA — Environmental Protection Agency (38) (38-5)
erosion — washing away of land (15-2)
essentials — things that are needed to live a basic life (2-2)
eutrophication — speeding up the natural aging process of a lake (37-2)
extinct — no longer alive (57-1)

F famine — a period of time when food is scarce (26-2)
felony — a bad crime (57-1)
fertility — capable of growing life (15-1)
filtration — separating by filters (34-1)
flouridation — adding flouride to strengthen tooth enamel (34-1)

G grazing — grass-eating animals (53-3)
grit — small, stony particles (37-5)

H habitat — place where a plant or animal lives (20-1)
Haiku — special form of Japanese poetry (44-1)
hazardous — full of danger (38-6)
herbivores — plant-eaters (51-1)
humidity — amount of moisture in the air (31)
humus — decayed organic matter (16-1)
hydrocarbons — air pollutant from unburned fuels (40-1)
hydroponics — growing plants in mineral-rich water (10-1)
hypothesis — what you think will happen (13-1)

I ignite — to start burning (42-1)
immature — young, not fully grown (55-4)
impact — effect (53-1)
inaccuracy — not correct (53-2)
incinerators — used to burn things (30-1)
inexpensive — reasonable in price (34-1)
inhabitants — residents (36-3)
injunction — a leagl command not to do something (38-3)
intolerable — cannot stand, horrible (53-1)
invisible — cannot be seen (47)
irrigation — to supply water for agriculture (26-2)

K kilowatt — measure of electrical usage (45)

L limestone — a sedimentary rock made up of the shells of small animals (55-3)
linked — connected (55-1)
litter — dead or discarded things on the surface of the soil (16-1)

M mass transit — moving many people at one time (43)
membrane — a thin sheet of material that lets certain liquids and solids pass through (33-1)
menace — one who causes injury (55-4)
mercury — a metal element which is a liquid at room temperature (37-2)
metropolitan — city-like (33-1)
microclimatology — small scale, climate studies (54-6)
middens — Indian garbage heaps (2-1)

N niche — place where a plant or animal can survive (51-1)
nitrogen oxides — pollutant produced by burning fuels (40-1)
non-renewable — cannot be used again (30-3)
nutritional — providing good food (3)

O organic material — material from living things (15-2) (16)
ornithologist — a scientist who studies birds (49)
osmosis — passing of liquids through a membrane (33-1)
oxidizing — combining with oxygen (42-1)

P particulates — small particles in the air (40-1) (41)
peccaries — a type of wild pigs (56-4)

P permanently — lasting forever (53-4)
permeable — can pas through (34-2)
persistent — long-lasting (49-5)
pH — measures whether a substance is an acid or a base (17)
phosphates — a salt containing the element phosphorus, found in fertilizers and detergents (37-2)
photosynthesis — process by which green plants produce food from sunlight, carbon dioxide and water (54-13)
plague — an epidemic disease causing widespread death (26-2)
pollutant — something that dirties air, water (40)
polyps — living parts of a coral (55-3)
population — number of plants or animals living in a region (24-1)
practicable — possible to do, necessary (38-6)
predator — one who preys on others (51-1) (53-1) (57-2)
preservation — keeping safe (3-1)
prey — animal that is hunted (51-1)
privilege — right, special favor (53-1)
procedure — how you do something (13-2)
producers — green plants that produce food (51-1)
promote — increase, move ahead (42-4)
psychological — mental, emotional (3-1)
psychrometer — an instrument for measuring relative humidity (54-9)

Q quirk — a trick (53-2)

R receding — going back (57-1)
recycling — repeating a pattern over and over (30-3)
reduced — made less (27-1)
registered — recorded in a book (38-3)
rehydration — adding water to a dehydrated material (3-2)
resemble — look like (3-1)
reservoirs — place where water is stored (36-1)

R restraints — something which holds back (3-3)
rine — the outside shell of a melon (2-1)
Ringelmann chart — chart used in measuring air pollution (41-1)
rotary — going in a circle (42-3)

S salinity — measure of salt in water (34-1) (36-4)
sanctuary — a place of protection (57-3)
sanitary landfill — a place to dump garbage and then the garbage is covered with dirt (30-1)
scavengers — animals that eat dead things (51-1)
sedges — small grass-like plants (56-3)
sedimentation — settling out of particles, mud, silt (34-1) (37-5)
sludge — mud, sediment from sewage disposal (37-5)
smallpox — a disease that causes pox (boils) on the skin (26-2)
species — a group of animals or plants that are alike (24-1)
specific — special, definite (38-6)
sponsored — introduced, supported (42-1)
spores — the seeds of certain types of plants (56-6)
stabalize — keep at one level (27-1)
stable — changing very little (57-2)
standardize — a basis for comparing like things (54-7)
strand — one thread of something (56-6)
substandard — below the standards set for drinking water (34-1)
succession — coming one after another in order (56-2)
sulfur dioxide — pollutant found in the air, produced by burning coal and oil (40-1)
sumac — a berry tree with red berries (2-2)
symbiosis — living together for mutual benefit (54-5)

T techniques — methods, ways of doing something (3-1)
technology — a method of making things, like machines (26-2)

T tertiary — the third, in sewage treatment; the third process to clean sewage before dumping (37-4)
thrives — to increase quickly (55-3)
transmission — to carry something in another thing (34-2)
triton — an animal with a large colorful coiled shell, like a conch shell (55-4)
typhoid fever — a disease causing headaches, caused by drinking "bad water" (26-2)

V vaccines — used to prevent disease (24-2)
variations — changes (54-7)
vegetarian — one who eats only vegetables (57-2)
vertically — up and down position (54-12)
villian — "bad guy" (53-3)

W wetmount — type of slide made using water (11-2)